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SULFUR OXIDES AND OTHER SULFUR COMPOUNDS. A BIBLIOGRAPHY WITH ABSTRACTS

Anna Grossmann Cooper

Public Health Service
Washington, D. C.

1965

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A BIBLIOGRAPHY WITH ABSTRACTS

COMPILED BY
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PREFACE

> The systems which confront the intelligence remain basically unchanged through the ages, although they assume different forms...There is nothing so disastrous in science as the arrogant dogmatism which despises the past and admires nothing but the present.
>
> J. C. F. Hoefer

In this atomic age--with its ever-expanding industrialization, new chemicals, spacecraft, and a population which has doubled in the last 50 years--air pollution has become a crucial problem and an important field of scientific study. After many years of neglect, the importance of gaseous--as against solid--pollutants has finally been realized. Among the most ubiquitous are the oxides of sulfur.

They are also among the most harmful--to human health, to vegetation, and to materials, including even stone edifices which have weathered many centuries of purer air unimpaired.

In fact, some of the earliest monuments of antiquity have deteriorated rapidly in recent years because of sulfuric acid, a strong and most corrosive acid, which results when the oxides of sulfur emanating from an ever-increasing number of sources combine with water vapor. In order to preserve precious works of art, the Cloisters Museum of Medieval History in New York keeps nearly all its works of great value indoors.

How can we protect ourselves from being attacked by so dangerous a substance in the air around us? How can we protect livestock and vegetation from the effects of these sulfurous fumes? This problem is more acute today than it ever has been before. Past air pollution episodes which have taken swift tolls in human lives have given us a forewarning of what could happen on an even larger scale if we are not mindful of the dangers encroaching upon us.

Just as many diseases are no longer regarded as inescapable scourges of mankind to which we must meekly submit, neither can the pollution of our air be regarded as something we have to tolerate as an inescapable tribute to be paid for our modern way of life and the high standard of living it makes possible for us.

But it would be erroneous to assume that the oxides of sulfur are a creation of 20th century man, new end-products of his modern chemistry. For the diligent researcher can find reference to sulfur in history and literature ever since written history and literature began. While these earlier mentions can contribute little to the practical utility of a sulfur bibliography, a brief survey in this preface of some of the more interesting may add a welcome touch of color to what must otherwise be, from its nature, a very dry volume indeed.

Homer mentions sulfur as a purifying element. Ignited sulfur is mentioned in the early records of many countries as having been used in religious ceremonies. For many centuries, the occurrence of sulfur in the vicinity of volcanoes and the pungent odor it emits when burned caused it to be regarded as a symbol of evil. Specific reference to sulfur fumes with regard to their adverse effects on health go as far back as Pliny the Elder. Pliny was not only an admiral but also a scholar and a writer; he wrote about the "science" of his day and has furnished us with some details on its chemical industries. Pliny was Prefect of the Roman fleet at the time of the eruption of Vesuvius (A.D. 79) which buried in its ashes Pompeii and Herculaneum. He lost his life by approaching the volcano to get closer observations and to aid refugees. Exhausted by his efforts he rested on the beach, where he was overcome by the sulfurous fumes. "Leaning on two slave boys he rose to his feet but immediately collapsed...his breathing was impaired, and his windpipe, constitutionally weak and narrow and chronically inflamed, was obstructed by heavier fumes." When the light of the day was restored, two days after it had last been seen,

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his body was discovered whole and with no signs of violence, his clothing undisturbed. He had evidently been asphyxiated by the abnormally polluted air. We are indebted for this account to Pliny the Younger, a nephew, who reported it to the historian Tacitus.

Moses Maimonides, physician and philosopher who was born in Cordova in 1135, expressed his concern about the effects of air pollution on the health of man in a "Treatise on Asthma," which only in 1963 has been translated into the English language. This book still merits our attention, in spite of the great advances we have made in the theoretical and practical aspects of allergic diseases. Maimonides became the personal physician to the son of the Sultan Saladin of Egypt, who suffered from asthma. His advice to the prince in regard to his affliction is full of wisdom. In his treatise he gives advice to the well and to the unwell..."keeping clean the air which we breathe...It is well known that clean, fresh air free of any contamination is advisable for all people, whether healthy or sick." He advised the prince to leave highly "industrialized," polluted Alexandria on those days when his sufferings were most acute, and to go to Cairo. Indeed, the prince felt much better in the clean air of Cairo.

History mentions sulfur in connection with industry as early as the early Renaissance, when iron foundries were developed. Two of these--at Grottaferrata, near Rome, and at Ferrier, in the valley of the Nure, in the Apuan Alps--were described by the Florentine, Antonio di Piero Averlino (born about 1400), called Filarte. According to Filarte, the iron ore was first improved by roasting with lime, and he ascribes this process to an attempt to reduce the high sulfur content, which he notes at various points in the process. The following is excerpted from a translation of Filarte's description of the Ferrier smelter: "... near the bellows was a sort of well where water always flowed and which was always full. In it they poured the molten iron. It stayed red for a good distance down. This water smelled very badly; there was sulphur in it." In his narrative on the smelter at Grottaferrata, Filarte describes how the ore is dug and prepared for the charge and continues: "They say that they usually make twenty to twenty-five charges a day. When it is drawn off, it smells strongly of sulphur so that I think it must contain a great deal of sulphur. The same is true of the flames that come out of the furnace with almost the same color as burning sulphur....In the evening especially, when you see these persons working around the flame whose light strikes them on the face, they look like dead men. It is the strangest thing in the world, especially since the men working at this task look like those who torment the souls of the damned."

The origin of alchemy has often been associated with early evidences of the importance attached to gold, and sulfur played a great part in the attempts at making gold.

The early alchemists believed that sulfur, mercury, and salt were the three substances contained in all minerals, metals, and the organisms of plants and animals. Sulfur, representing the principle of inflammability, was supposed to be present in all metals. It was the belief that all metals were composed of "philosophic" sulfur and "philosophic" mercury, which could be obtained by art from the base metals, and recompounded to form noble metals.

> "Therefore, if clean, fixed, red and clear sulphur fall upon the pure substances of Argentive (being itself not excelling, but of a small quantity, and excelled), of it is created pure gold. But if the sulphur be clean, fixed, white and clear, which fall upon the substance of Argentive, pure silver is made...Yet, this hath a purity of gold, and a more gross inspissation than gold hath."
>
> (Ibir or Geber, 8th Century)

From the early part of the Christian era to about 1500 A.D., the search for the Philosophers' Stone, a substance by which baser metals could be converted into gold, led to exhaustive studies of all available materials. In this way it led to the discovery of many new processes and compounds. In the 15th century the quest for the Philosophers' Stone and the Elixir of Life, magic sources for wealth, health, and long life, were the great and final goals of alchemy.

It is due to the great Swiss physician, Paracelsus, who lived during the first half of the 16th Century, that chemistry (or alchemy, as it was known at that time) was raised to the high rank it deserved even then. Paracelsus did not acknowledge that the ultimate aim of alchemy was only to produce gold. He knew something of sulfur's bleaching power, and that it was also used in the art of healing. Paracelsus insisted that chemistry's primary utility was for the preparation of medicines. His idea proved prophetic; not long afterward, chemistry was being taught in colleges and medical schools and today, of course, it is indispensable to the medical profession.

Among the early skeptics of the "three-substance" theory of metals was Vanuccio Biringuccio (Siena, 1480). Although little known, he had an extensive knowledge of metallurgy and technology and did not believe in the theory that metals are formed from mercury and sulfur. Early works of Robert Boyle were also devoted to proving the fallacy of this assumption. With his book, "The Sceptical Chymist" (1661), which is a critical analysis of the Aristotelian theory and of the three principal substances, sulfur, mercury, and salt, he practically wrote the death sentence of alchemy. Justus Liebig (1803-1873) takes a more generous view of tne aspirations of the alchemistic period, which he expresses in these words:

> "The most lively imagination is not capable of devising a thought which could have acted more powerfully and constantly on the faculties of men, than that very idea of the Philosophers' Stone. Without this idea chemistry would not now stand in its present perfection...In order to know that the Philosophers' Stone did not really exist, it was necessary that every substance accessible...should be observed and examined...But is is precisely in this that we perceive that almost miraculous influence of the idea. The strength of opinion could not be broken till science had reached a certain age of development."

While theirs were often only "voices crying in the wilderness," at least a few men of science had become concerned about air pollution over 300 years ago. For example, Sir William Harvey (1578-1657), renowned for the discovery of the circulation of the blood and as a planner for the first Pharmacopoeia, was also an advocate of smoke abatement and had an important influence on public health. He realized the dangers to the health and well-being of man by the pollution of the air and he wrote the following in a postmortem report:

> "The cause of death seemed fairly referable to a sudden change in the non-naturals, the chief mischief being connected with the change of air, which through the whole course of life has been inhaled of perfect purity--light, cool and mobile, whereby the precordia and lungs were more freely ventilated and cooled; but in this advantage, in this grand cherisher of life this city is especially destitute; a city whose grand characteristic is an immense concourse of men and animals, and where ditches abound, and filth and offal lie scattered about, to say nothing of the smoke engendered by the general use of sulphurous coal as fuel, whereby the air is at all times rendered heavy, but much more so in the autumn than at any other season. Such an atmosphere could not have been found otherwise than insalubrious to one coming from the open, sunny and healthy region of Salop; it must have been especially so to one already aged and infirm."

The indignation we feel today at seeing our cities "wrap their stately heads in clowds of smoake and sulphur, so full of stink and darkness," was felt by John Evelyn (1620-1706) long before the industrial revolution. Evelyn's words are unfortunately still true in what we like to regard as the highly cultivated society of today's atomic age.

We are still in quest of the Philosophers' Stone, of the Elixir of Life. We in the 20th Century are not free of the longing for health, beauty, and eternal youth. We trust our modern "alchemists" with the task of freeing the air, which Evelyn calls "the vehicle of our soul," of obnoxious gases, and of cleaning our environment of the evil floating in the air. The achievement of this would, undoubtedly, be a step towards the fulfillment of man's dreams.

The U.S. Department of Health, Education, and Welfare is very much concerned with the growing problems of air pollution, including those problems which involve the pollution of the air by the oxides of sulfur. In fact, the Clean Air Act of 1963--which, in this and many other ways, has greatly expanded the potential for more effective Federal leadership in the Nation's efforts to conserve its vital air resource--specifically called for the development of low-cost methods for removing sulfur from fuel, in order to reduce the volume of sulfur dioxide and other sulfur compounds released into the atmosphere. Accordingly, the Public Health Service has directed some of its scientists in the Division of Air Pollution to concentrate on sulfur studies. The Public Health Service also sponsors and supports such studies by other Government Agencies and by universities and other nonprofit organizations. In addition, certain industrial groups have a high stake in this issue and are supporting independent studies.

This bibliography has been compiled to assist all who are engaged, or may become engaged, in studies of sulfur compounds in their relation to air pollution. Although the compiler is aware that this bibliography of materials chosen from the vast and ever-increasing literature on this subject represents only a small selection, it is hoped that it will become a valuable reference tool.

A.G.C.

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Hoefer, Jean-Chrétian-Ferdinand: Born in Germany 1811, died in France 1878. At first studied medicine. Published 1840 "Studies in Chlorosis." Hoefer is known for his great work "Histoire de la chemie." 2 vol. Paris 1842-1843.

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INTRODUCTION

Although this annotated bibliography on sulfur oxides and other sulfur compounds includes publications from 1893 to 1964, it is by no means all-inclusive.

Many sources have been used in preparing this bibliography, including other bibliographies, books, journals, and reviews on the subject of sulfur dioxide and other sulfur compounds. Where an abstract has been adapted from other bibliographic sources, credit is given by adding the abbreviation of the publication at the end of that particular abstract. (See Glossary of Abbreviations.)

The bibliography proper is arranged under 13 subjects. Within each subject the abstracts are arranged by first author, or by first significant word in the title, if no author is given. Since many articles contain material on several phases of the subject, an effort has been made to place each abstract under the most pertinent subject. An item number at the upper left of each abstract is used for identification.

To facilitate finding the specific item which interests the reader, several supplementary indexes have been added.

The Title Index is arranged alphabetically within each of the 13 subjects. A number at the end of each title refers to the corresponding number of the abstract.

The Author Index is an alphabetical index of all authors. It lists the number of the corresponding abstract and, in parentheses, the year of publication. Dashes and commas are used to indicate whether the author is the principal, second, third, or fourth author, etc. For example:

Carey, G.C.R., 442(1958),-,-,237(1958)

This indicates that Carey, G.C.R., is the principal author of item 442, but the third author of item 237; or:

-,Cariadi, L.,953(1958)

This indicates that Cariadi, L., is the second author of item 953. Where the number of entries exceeds four, listing is made also by year of publication, with the number of the pertinent abstract in parentheses.

In the case of multiple authors, all U.S. authors are listed, whereas no more than three foreign authors are listed, in any one entry.

The Geographic Location Index has two major divisions, U.S. and foreign. U.S. studies are listed alphabetically by State or city only when specific mention of location is made; foreign studies are listed alphabetically by country. All entries include the corresponding number of the pertinent abstract and in parentheses the year of publication. Multiple entries under a single location are also listed chronologically by year of publication with the item number in parentheses.

It should be noted that the titles of journals are abbreviated (see List of Journals and Their Abbreviations). The months are also abbreviated, except the months of March, April, May, June, and July. A typical entry reads as follows: J. APCA 2:146-151 (May) 1963. This indicates that the article appeared in the Journal of the Air Pollution Control Association, Volume 2, pages 146-151, May 1963.

In order to make a distinction between journal articles and monographs, conference, or report titles, the titles of articles are typed in lower case, and other titles are capitalized.

A List of Journals and Their Abbreviations, and a Glossary of Abbreviations complete this bibliography.

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1. SOURCES OF OXIDES OF SULFUR

1. Anderson, D.R. and Manlik, F.P.: Sulfuric acid corrosion in oil-fired boilers. Studies on sulfur trioxide formation. ASME Trans. 80:1231-1238 (Aug.) 1958.

Experimental studies on economizer and air-heater corrosion resulting from the formation of sulfuric acid in residual-oil-fired boilers are described. Factors controlling the oxidation of sulfur dioxide to sulfur trioxide have been investigated in a small experimental boiler. The sulfur trioxide content of the flue gases was determined indirectly by measuring the corrosion of and sulfate deposition on a steel specimen maintained at a controlled temperature. In an initially clean boiler, approx. equal quantities of sulfur trioxide formed in the flame, furnace, and convection sections, while less formed in the economizer-air heater section. Nickel, iron, sodium, and vanadium in the fuel, each decreased the corrosion normally experienced by the test specimen, the magnitude of the effect increasing in the order given. Combinations of sodium and vanadium in the fuel were found to decrease corrosion in an initially clean furnace, but boiler deposits from certain combinations of these elements were found to increase corrosion substantially. This catalytic effect is predominant over extended periods of time. Discussion. 6 figures, 31 references. - APCA

2. Arkhipov, A.S. and Boitsov, A.N.: Air pollution with toxic substances in the sulfuric acid industry. Gig. i Sanit. 31:12-17 (Sept.) 1962.

General technical progress, introduction of an advanced method of pyrite roasting, mechanization of manual operations, introduction of automation, improvement of the ventilating system, and various other measures have contributed to the amelioration of working conditions in installations of the sulfuric acid industry. Judging by the data collected over a period of many years (9-15), the concentration of SO_2 in the air of the chamber of sulfuric acid plants has decreased to the standard hygienic level. Besides, a considerable achievement has been made in lowering the ash content in the air. Decreased atmospheric SO_2 levels have been attained in spite of highly technological processes and of the greatly increased outputs of sulfuric acid. - Authors' English Sum.

3. Arnol'di, I.A. and Velousova, A.Z.: Industrial air pollution in the Noril'sk area. In: Hygienic Problems of Human Adaptation in the Far North. Moscow, Medgiz, 1961, pp. 62-67.

Air pollution was noted regularly in the city of Noril'sk (a city north of the Arctic Circle), especially in the older part of the city. Studies showed the pollution levels to be very high in relation to the permissible limits for SO_2 and SO_3. The average amounts of SO_2 (in mg./m.^{3}) at various locations in the city were found to be: 1.34, 1.50 (in the old city), 1.24, 0.78, 0.54, 0.44, 1.13, and 0.55. A considerable amount of pollution by dusts, H_2S, and chlorides was also shown. Average levels of dust (in mg./m.^{3}) at three locations were: 0.64, 0.37, and 0.8. In the precipitated dust was found evidence of cobalt, lead, and several other substances which could not be considered as totally inoxious for humans, when appearing in the air. Interviews with inhabitants of the city indicated a close relationship between air pollution and the sanitary living conditions. The importance of the development of air pollution control systems, is noted. - APCA

4. Beckman, J.W.: Desulfurization of flue gases. U.S. Patent 2,718,453 (Sept. 20) 1955.

Removal of SO_2 and SO_3 from flue gases is accomplished by blowing finely divided solid $CaCO_3$ into the gas while at a temp. of at least 350°F. The following reactions are thought to occur: $CaCO_3 + SO_2 \quad CaSO_3 + CO_2$; $CaCO_3 + SO_2 + \frac{1}{2}O_2 \quad CaSO_4 + CO_2$; and $CaCO_3 + SO_3 \quad CaSO_4 + CO_2$. The $CaSO_3$ and $CaSO_4$ are removed from the gas stream by known methods. For example, a flue gas contg. 2.5% from combustion of a heavy fuel oil was treated with finely ground limestone in an amt. equal to 4 times the wt. of S. Analysis indicated that 90% of the SO_2 present had been converted to solid compds.- PHEA

5. Benarie, M.: Effect of shape of solid dust particles on their filterability. Staub 23:50-51 (Feb.) 1963.

Precipitation efficiency of metal filters with holes smaller than 20 µ was measured for methylene blue (mean diameter about 0.12 µm), quinalizarin (needles 3 µm long and a few hundredths µm thick) and silica dust (mean diameter about 3 µm). Tests conducted up to Re = 2 showed that the acicular particles are held by the fibres in absolutely unorientated manner. - English Sum.

6. Berger, B., Elliott, M.A., Holtz, J.C. and Schrenk, H.H.: Diesel Engines Underground. V. Effect of Sulfur Content of Fuel on Composition of Exhaust Gas. USBMRI 3713, 1943.

The composition of the exhaust gas produced by a commercial Diesel engine operating on a fuel of high sulfur content was determined. Test conditions included operation at minimum speed at minimum, intermediate, and maximum power outputs, and at maximum speed at minimum and approximately 70 per cent of maximum rated power output. Essentially all the sulfur in the fuel appeared in the exhaust gas as sulfur dioxide and sulfur trioxide. The ratio of sulfur dioxide to sulfur trioxide in the exhaust gas varied, increasing temperatures of combustion causing increases in the proportion of sulfur dioxide. No measurable increase was noted in the sulfur content of the engine lubricating oil as a result of operation with the high-sulfur fuel during a limited test period. This statement is made only to confirm the results of exhaust-gas analyses, which showed that with respect to exhaust-gas composition all the sulfur in the fuel may be considered as appearing in the exhaust as sulfur gases. Test results are compared with similar data obtained at comparable operating conditions with a fuel of low sulfur content. Variations in the concentrations of carbon monoxide and oxides of nitrogen may be attributable to differences in the physical characteristics of the two fuels. The test results are discussed in connection with the use of Diesel engines in underground working places. It is concluded that the sulfur content of the fuel for Diesel engines in such application should be limited to 0.3 to 0.4 per cent, as otherwise ventilation requirements would have to be increased to dilute the sulfur gases in the exhaust to concentrations permissible in working environments. - Authors' Sum.

7. Berk, A.A. and Burdick, L.R.: A Method of Test for SO_2 and SO_3 in Flue Gases. USBMRI 5618 (J[illegible].) 1950.

In the course of a study of the formation of external deposits on tubes in water-tube boilers it became desirable to determine the sulfur dioxide (SO_2) and sulfur trioxide (SO_3) in the flue gases. Determinations made by the A.S.M.E. method for SO_2 and SO_3 in gaseous products of combustion did not give accurate results. It was found that minute quantities of copper, present in the flue gases from the coal in use, caused oxidation of sulfite in the absorption bottle and that the carbon dioxide (CO_2) in the flue gases caused high value for SO_2. The A.S.M.E. test procedure was revised to prevent oxidation of sulfite in the absorption bottle and to allow for the effect of CO_2; subsequent analyses of flue gases produced reliable results. The revised procedure is described. - Authors' Sum.

8. Bidaut, M., and Billon, P.: The measured amounts of sulfur in combustible materials. Rev. Assoc. Prevent. Pollution Atmospherique (APPA) (Paris) 3:19-36 (Jan.-Mar.) 1961.

Sulfur contained in combustible material results in the production of corrosive reactions at the site of the burning and also in the release into the air of sulfur dioxide and sulfuric acid. It is estimated that 1 ton of fuel with a 1% sulfur content produces about 30 kg. of H_2SO_4. The laboratory of the (O.C.C.R.) Office Central de Chauffe Rationnel has made a study of ways available to determine the content of sulfur in samples of solid, liquid, and gaseous combustible materials. Other aspects of the problem studied were the effects of "desulfurants," catalyzers of combustion, neutralizing substances added to the fumes, and of the causes, effects, and remedies of corrosion. Much of this article is devoted to an enumeration, and sometimes an evaluation, of various methods used to measure sulfur content in fuels. Due to lack of space these methods are not given in detail but references to this information are given in the bibliography. There are several tables in the text which show comparative results of various analyses for solid, liquid, or gaseous fuels. - APCA

9. Bienstock, D. and Murphy, E.M.: Chemistry of sulfur dioxide. USBMRI Bruceton, 1956. 58 pp., and Fuel Abstr. (London) 20:155 (Dec.) 1956.

The contamination of the atmosphere by sulfur dioxide, whether formed in dilute concentrations of 0.05 to 0.25% in the flue gases of power plants or as much as 5 to 10% in the roaster gases of smelting plants and waste gases of sulfuric acid plants, has been a public health problem for many years. The Bureau of Mines is currently engaged in a cooperative project with the U.S. Public Health Service directed toward development of processes for treating such effluents to minimize their noxious and toxic properties by removal of the sulfur dioxide. One phase of this investigation involves a compilation of published information relating to the chemistry of sulfur dioxide, emphasizing reactions having potential application to the problem. Reactions involved in some gas purification processes have been reviewed with no effort being made to evaluate the material which is presented to serve as an annotated bibliography. - APCA

10. Bienstock, D., Brunn, L.W., Murphy, E.M., and Benson, H.E.: Sulfur dioxide - its chemistry and removal from industrial waste gases. USBMIC 7836, 1958, 96pp.

Contamination of the atmosphere by sulfur dioxide, whether in dilute concentrations of 0.05 to 0.3 vol.-% (such as in the flue gases of power plants) or as much as 5 to 10% (as in the roaster gases of smelter plants) has been a public health problem. The Bureau of Mines and the U.S. Public Health Service are participating in a project for developing processes that remove sulfur dioxide from gaseous effluents or minimize their noxious and toxic properties. One part of this report is a compilation of published information on the chemistry of sulfur dioxide, emphasizing reactions having current and potential application to the problem of air pollution. In commercial methods for removing sulfur dioxide from powerplant flue gases, gas-liquid contact is employed almost exclusively. The major absorption processes developed or in the pilot-plant stage are discussed. In the remainder of the report, the authors suggest alternative methods of reducing pollution. By lowering the sulfur concentration in the coal before combustion, by coal cleaning and partial gasification, reduction in the sulfur dioxide content upon combustion will be accomplished. 6 tables. 14 figures. 253 references. - APCA

11. Bienstock, D. and Field, J.H.: Bench-Scale Investigation of Removing Sulfur Dioxide from Flue Gases. Proc. 52nd Annual Meeting, Los Angeles, Calif., June 21-26 1959, 13 pp., and J. APCA 10:121-125 (April) 1960.

As evidenced by the bench-scale tests, removal of sulfur dioxide by using solids from a simulated flue gas at elevated temperatures is possible. Further engineering and cost studies will be undertaken to determine if this technique is feasible on a commercial scale. Although the capital and operating costs for a purification process will of necessity be high, public pressure for cleaner air may require consideration of purification processes by enactment of legislation reducing the allowable concentration of sulfur dioxide in flue gases. - APCA

12. Bienstock, D., Field, J.H. and Myers, J.G.: Process Development in Removing Sulfur Dioxide From Hot Flue Gases. I. Bench Scale Experimentation. USBMRI 5735, 1961, 29 pp.

Problem of sulfur dioxide pollution. Magnitude of sulfur dioxide pollution. Legislation regarding sulfur dioxide. Methods of reducing sulfur dioxide pollution. Operating procedure. Absorption. Alkalized alumina absorbent. Effect of alkali, sulfate, water vapor. Regeneration of spent sodium alumina absorbent. Proposed industrial application for scrubbing flue gas. Manganese oxide absorbent. Electrolytic regeneration of manganese sulfate. Adsorption. Activated carbons. Molecular sieves. Oxidation catalysts. Future studies. This report is the first of a series of four publications by the Bureau of Mines on the engineering development of a process for removing sulfur dioxide from flue gases. Later reports will cover the design and operation of a small-scale, pulverized coal fired furnace, pilot plant investigations, using flue gases from the furnace, and cost estimates for a commercial installation. - APCA

13. Bienstock, D., Field, J.H. and Myers, J.G.: Removal of sulfur oxides from flue gas with alkalized alumina at elevated temperatures. Digest (CEGB) 15:12 (Dec. 21) 1963.

A cyclic process is described for removing the oxides of sulfur from flue gas by absorption at 625°F and then converting the oxides to elemental sulfur by reduction of the spent absorbent. Pilotplant experiments are reported in which a solid absorbent of alkalized alumina in free and baffled fall is used to remove SO_2 and SO_3 from the combustion gas of a pulverized-coal-fired furnace. The absorbent is then regenerated by heating with hydrogen or with steam-reformed natural gas. Fly ash does not interfere and attrition is negligible.

14. Boie, W.: Problems of preventing smoke damage from furnaces. Energietechnik 5:498-506 (Nov.) 1955.

The author considers in some detail various approaches to the problem of preventing sulfur pollution, viz: the removal of sulfur by water washing and other washing techniques; the construction of special stacks aimed at creating maximum dilution; the removal of sulfur prior to burning the coal. The nature of the occurrence of sulfur in coal and its behavior during combustion are examined, and some tests were conducted to gain information on the proportion of sulfur combined in the ash and that volatilized when different coals were burned. The merits and demerits of various standard types of flue gas cleaning equipment are discussed, and the effect of cyclone firing on sulfur emission is mentioned as a problem requiring fresh study.- APCA

15. Brasser, L.J.: Some aspects of the pollution of the atmospheric air. Mens en Onderneming (Haarlem) 17:136-146 May 1963.

Following an historical review of the problem of atmospheric pollution, the various sources of pollution are discussed. The situation in the Netherlands is described in some detail. The country has the advantage of being located so that the prevailing westerly wind comes in over the North Sea and the air is relatively clean. Also the land is flat and the winds are fairly brisk. This favorable, natural condition is often quoted as an argument in opposing the installation of gas cleaning systems. The increasing density of population and industrial development in the western part of the country has resulted in increasing numbers of domestic heating units and increasing automotive traffic. During temperature inversion periods the air pollution levels can become quite serious. In heavily industrialized areas, such as Amsterdam, Zaanstreek (region of De Zaanstreek, near Amsterdam), Ijmond near Rotterdam (Ijsselmonde), and along the Nieuwe Waterweg (New Waterway), the pollution levels are high and steadily increasing. At Ijmond, contamination comes both from the mining activities and from its proximity to the Waterweg. In other locations, such as the mining areas around Limburg, the pollution problem is also one to be reckoned with. In 1958, the T.N.O. (Nederlandse centrale organisatie vor Toegepast-Natuurwetenschappelijk Onderzeek; Netherlands Central Organization for Applied, Natural Science Investigation) made a study of the amount of pollution in the area around The Hague, Rotterdam, Dordrecht, and DeBeer (Rosenburg). Emissions from public utilities and from industry combined, produce a high level of SO_2, but the flue gas emitted from public utilities is also high. A tabulation of these findings is given as follows:

	Tons of pollution/yr.		
	SO_2	Sooty material	Flue gas
Domestic fires	15,200	7600	2300
Public utilities	28,300	little	6500
Industry	24,200	3100	900
Navigation	1 300	1100	little
Road traffic	900	500	None
Heating of multi-unit buildings	7 400	3000	600

APCA

16. Britain's newest sulfuric acid plant. Chem. Age. (London) 73:1209-1212 (Dec. 3) 1955.

The plant is located at Whitehaven, Cumberland, and has been in operation for a few months. It uses anhydrite from the mine on the site, which is 300 ft. below ground and is reached by two 1000 yd. long drifts with a slope of 1 in 7. An average output of 350,000 tons of anhydrite a year is expected. This is double the original estimate and the surplus is being sold for the manufacture of sulfate of ammonia. The anhydrite leaves the screening and crushing plant in pieces of 3/4 in. size and fed to the raw material silos together with the correct proportions of shale and coke to a ball mill. The mixture is ground to a fine powder and pumped to the raw meal silos where it is analyzed and fed to kilns. The gases leaving the cold end of the kilns contains 8 1/2 to 9% sulfur dioxide. They are filtered, cooled and dried by conventional methods before being passed on to the sulfuric acid plant. The dried gas passes through blowers into converters containing the vanadium catalyst. Because of the possible effects of acid fumes in the atmosphere, all outdoor transformers are hermetically sealed - distinct from the more usual practice of providing them with conservators. They have also been coated with a sulfuric acid resisting paint. - APCA

17. Buck, M.: Measurement and evaluation of SO_2 emissions. I. Measurement of SO_2 emission on one locality. Staub 22:193-199 (June) 1962.

This article is an evaluation of SO_2 emission measurements. Relationships were found between the frequency of measurement and the factors characterizing SO_2 emission. With increasing frequency of measurement the factors, arithmetic and geometric average values (frequency distribution and frequency with which the tolerance limit is exceeded) change less and vary little about a mean value. With this type of evaluation the possibility exists to make predictions about SO_2 emission in areas for longer and shorter periods of time. - English Sum.

18. Carpenter, H.C. and Cottingham, P.L.: A Survey of Methods for Desulfurizing Residual Fuel Oil. USBMIC 8156, 1963.

This literature study of methods for desulfurizing residual fuel oil was conducted by the Bureau of Mines at the request of the Department of Health, Education and Welfare. The sulfur compounds in residual fuels are believed to consist chiefly of condensed thiophenes and other polycyclic sulfur compounds. Hydrodesulfurization appears to be the most promising method for desulfurizing these oils and is the only method applicable to all types of sulfur compounds. There are indications in the literature that hydrodesulfurization without hydrocracking of residual oils may require higher pressures than used in present desulfurization processes, but no cost data and little experimental data are available on the higher pressure operation. Literature proposals for hydrogenating residual oils and heavy crude oils are exclusively for hydrocracking the oils to lower boiling products with accompanying partial desulfurization of the residual fuel fraction. Costs of the hydrocracking operations appear the closest available to probably costs of hydrodesulfurizing the oils, and have been reported (in 1955 to 1957) as $500 to $840 investment cost per daily barrel of capacity, with total operating costs of 70 cents to $1.10 per barrel. - Authors' Abst.

19. Cave, G.C.B.: The collection and analysis of odorous gases from Kraft Pulp Mills. Part I. Theoretical considerations. Part II. A Laboratory study of the collection of pollutants for analysis. Part III. The analysis of collected pollutants by gas chromatography. Part IV. A field kit for the collection of the pollutants, and methods for their analysis. Tappi 46:1-20, (Jan.) 1963.

A method for the collection and analysis of gaseous effluents and process streams from pulp mills is described. It provides for the collection of samples in the field, and for analysis by gas chromatography. The kraft mill pollutants include hydrogen sulfide (b.p. -59.6°C.), methyl mercaptan, sulfur dioxide, dimethyl sulfide, and dimethyl disulfide (b.p. 109.5°C.). Formulas provide quantitative information on the performance of traps towards pollutants having a wide range of boiling points and give the concentration of a pollutant in the solvent, as a function of the sample vol., sampling time, percentage of a pollutant retained in a trap from a polluted air stream, and the instantaneous concentration of a pollutant in the exhaust air from a trap. The distribution ratios of methyl mercaptan, hydrogen sulfide, and sulfur dioxide between an air stream and a solvent are calculated, and for the 1st 2, values are also found by experiment. - APCA

20. Chapman, W.R. and Jones, O.C.: The removal of sulfur from coal. J. Inst. Fuel 28:102-108 (Mar.) 1955.

The distribution of the sulfur-containing ingredients of raw coal is discussed, and it is shown that much of the sulfur is irremovable by present methods of coal preparation, based as they are on differences in appearance, in density, or in surface properties. The problem of removing sulfur reduces to the elimination of pyrites present either as discrete particles or as particles in association with coal and in quantity sufficient adequately to influence one or other of these properties. The effects of grinding are considered and results of cleaning by froth flotation and on concentration tables are given. Attention is paid to the particular problems of reducing the sulfur content of domestic and coking coals. Tabular data on cleaning operations are presented. - APCA

21. Chertkov, B.A., Aristov, G.E. and Puklina, D.L.: Absorption of sulfur dioxide from flue gases in an absorber of the bubble type. Atmospheric Poll. Bull. 24:50 (June) 1956.

Experiments at a power station are reported. Sulfur dioxide was absorbed from flue gases by ammonium sulfite-bisulfite in 220 mm diameter tower having 4 to 6 bubble plates of perforated aluminum sheet. 90% removal of sulfur dioxide was achieved and the rate of absorption was 10 to 20 times that in a packed absorber of the same size. Authors' Abst.

22. The Chlorine Oxidation of Sulfur Compounds in Dilute Aqueous Solution. Atmospheric Pollution Technical Bulletin, no. 18. June, 1963.

In recent years, the pulp industry has sought methods for decreasing the concentration of sulfur-containing chemicals in stack gases. The sulfur content of the gaseous requiring treatment is below the level where economic recovery is feasible. One method of treating such gases would be to scrub the gases with water, removing the water soluble sulfur compounds. These sulfur compounds could then be oxidized with chlorine or another oxidant and released.

In order to determine the chlorine requirements of this system, investigations were made of the chlorine oxidation of hydrogen and sodium sulfide, methyl mercaptan, dimethyl sulfide, and dimethyl disulfide. - Author's Abst.

23. Clauss, N.W.: The reduction of atmospheric pollution from sulfuric acid recovery processes. Air Repair 3:131-136 (Feb.) 1954, and Indust. Hyg. Digest, 18:37 (Feb.) 1954.

The experience of sulfuric acid manufacturers in devising and testing means of air pollution control is related. Some methods that were not entirely successful are described briefly, and extensive data are presented on the successful methods, especially the high pressure water fog system. The estimate of costs and savings gives a net cost of 2 cents per ton of acid concentrated for the process concerned. - PHE

24. Coal Producers Committee for Smoke Abatement: A Study of Smoke and Air Pollution in the Kanawha Valley. Cincinnati, Ohio, 1949, 78 pp.

An air pollution survey was conducted in the Kanawha River Valley around Charleston, W. Va., i.e., from Cabin Creek to and including Nitro. 29 large and small plants were inspected in that area. The relative concentrations of settled solids (sootfall) deposited in the area were measured at 12 separate locations in the valley for 24 hr. periods on Oct. 18, 19 and 20, 1949. These were compared with the quantitative results obtained by the W. Va. Dept. of Health, Bureau of Industrial Hygiene at 10 of these stations in the years 1945-47. These latter results are tabulated. The Oct.-Nov.-Dec. averages for 1949 were: 420 tons/sq. mi./yr. at Davis Creek; 560-Dunbar City Bldg.; 521-Spring St., So. Charleston; 430-Park Ave., Charleston; 1737-So. Charleston City Bldg.; 576-Virginia St. E., Charleston; 856-State Capitol Bldg.; 647-Owens; 929-No. Charleston and 4137-Belle Lock 2. These values were, in general, comparable to the 1947 year averages. The major air pollutants were fly ash, smoke, metal fumes and dusts, coal dust, cinders, tar vapors, H_2S, gaseous Cl_2 derivatives, CS_2, N oxides and SO_2. From the inspections made of the larger plants in the valley it appeared that, in general, excellent progress had been made in the period since the close of World War II in abating air pollutants. Observations of the sources and extent of pollution in the valley were also made from the air. The reports of individual plants, of railroad operations and of the meteorological conditions are given. - KB

25. Colclough, T.P.: The Role of Sulfur in Iron and Steel Making. Paper No. 55-APC-6. ASME Comm. on Air Pollution Controls, First Internat. Congress on Air Poll., New York, N.Y. March 1-2, 1955.

It is common knowledge that the presence of sulfur in iron and steel (except in certain special conditions) is harmful, and rigid limits on the amount permissible are imposed by standard specifications. For ordinary commercial steels, the maximum sulfur content is specified as 0.06%, for steels subjected to deep-drawing operations 0.025%, and for certain special qualities even lower limits are imposed. It is equally well known that practically all the raw materials (iron ore, limestone, and particularly the fuel used in the manufacture of iron and steel) contain sulfur in varying but marked degree. The purpose of this paper is to examine the quantity of sulfur involved, the effect of the sulfur in the manufacturing processes, the manner in which the sulfur is dealt with and, in particular, the form and quantity of sulfur which is disposed of in gaseous form. - Author's Sum.

26. Cole, R. and Shulman, H.L.: Adsorbing sulfur dioxide on dry ion exchange resins: for reducing air pollution. Indust. Eng. Chem. 52:859-860 (Oct.) 1960.

Considerable effort has been directed toward reducing or eliminating the discharge of waste sulfur dioxide to the atmosphere. Ion exchange resins, because of their porous nature might be used as adsorbents in gas solid systems for the removal of sulfur dioxide from waste gas streams. This article describes the work undertaken to determine the adsorptive capacity-temperature characteristics of dry ion exchange resins in contact with air-sulfur dioxide mixtures. The data obtained are compared with those in the literature for silica gel, gas-adsorbent carbon, and molecular sieves. - APCA

27. Corbett, P.F. and Fereday, F.: The sulfur trioxide content of the combustion gases from an oil-fired water tube boiler. J. Inst. Fuel 26:92-106 (Aug.) 1953.

An investigation into the effect of fuel, load, and carbon dioxide on the sulfur trioxide content of flue gases from an oil-fired boiler is reported, with statistical analysis of the results. It is shown that SO_3 can be produced in oil-fired boilers in amounts sufficient to cause some trouble from low-temperature surface corrosion, if preventive arrangements are not made. With all the oils tested, from 1 to 3% of the sulfur dioxide is oxidized to trioxide, giving rise to dew points of from 250 to 300°F. No direct relationship was observed between the SO_3 and the total sulfur in the oil. The work has confirmed the results of previous laboratory investigations. - Cond. Authors' Sum.

28. Crumley, P.H. and Fletcher, A.W.: The formation of sulfur trioxide in flue gases. J. Inst. Fuel 29:322 (Aug.) 1956, and Smokeless Air, Autumn 1956.

The factors controlling the oxidation of sulfur dioxide (SO_2) to sulfur trioxide (SO_3) in the combustion of fuels containing sulfur have been investigated in a small kerosine-fired furnace. The SO_3 contents of the flue gases from the furnace were determined chemically, and were shown to depend on the sulfur content of the kerosine, the flame temperature, the amount of excess air and type of flame. The SO_3 content of the flue gases from a large oil-fired boiler has also been determined and compared with the results obtained in the small furnace. - PHE

29. Crumley, P.H., Howe, H. and Wilson, D.S.: The automatic determination of sulfur trioxide in flue gases. J. Inst. Fuel 31:378-382 (Sept.) 1958.

An instrument is described for the automatic determination of sulfur trioxide and sulfuric acid vapor in flue gases in the range 10 to 100 ppm by volume. The instrument operates by absorbing the sulfur trioxide in an isopropyl alcohol solution and precipitating it as a barium sulfate; the optical density of the suspension is then measured photo-electrically. Tests have shown that the instrument gives results which are more consistent than those normally obtained by manual determination made by established methods. - APCA

30. Cuffe, S.T.: Air pollutants from power plants. Techniques for evaluating air pollutants. Arch. Environ. Health 6:422-427 (March) 1963.

Information in the literature concerning air pollutant emissions from coal-fired power plants is very incomplete. With the exception of some data on sulfur dioxide and smoke emissions, published information is limited almost wholly to fly-ash concentrations. The effects of method of operation, type of boiler furnace, and type of coal on formation of air pollutants and on stack emissions should be determined. This information would be helpful in evaluating methods for reducing air-pollutant emissions. For these reasons the United States Public Health Service and the United States Bureau of Mines are jointly conducting an intensive study of emissions from large coal-fired power plants, an importent source of air pollution in most industrial complexes.

The objective of the study is to evaluate the emissions of oxides of nitrogen, oxides of sulfur, polynuclear hydrocarbons, total hydrocarbons, total solids, formaldehyde, organic acids, and common metals in the gases emitted from various types of coal-burning power plants which may be useful in establishing the range of atmospheric emissions under various conditions of operation. Determination of the efficiencies of control equipment is also essential for the long-range objective of reducing total air pollution.

This paper describes the sampling and analytical techniques used in evaluating the several types of emissions under study.

31. Cuffe, S.T., Gerstle, R.W., Orning, A.A., and Schwartz, C.H.: Air pollution emissions from coal-fired power plants. J. APCA, in press.

The objectives of the study are the assessment of a number of flue-gas-stream components of interest in urban air pollution. These components are sulfur oxides, nitrogen oxides, polynuclear hydrocarbons, total gaseous hydrocarbons, solid particulates, formaldehyde, organic acids, common metals, and carbon monoxide. In addition, oxygen and carbon dioxide were determined. The over-all study includes a comprehensive evaluation of the effects of method of operation, type of boiler furnace and auxiliaries, and type of coal on the concentrations of gaseous and particulate pollutants in the products of combustion. This first report is concerned only with air pollutant emissions from two types of power-plant furnaces that burn coal.

32. Cummings, W.G., and Redfearn, M.W.: The concentration of sulfur dioxide in the atmosphere near power stations. J. Inst. Fuel 32:358-363 (Aug.) 1959.

Microquantities of sulfur dioxide were measured near 11 power stations using the Central Electric Research Laboratory (CERL) portable sulfur dioxide meter. (J. Inst. Fuel 30:628, 1957). Sulfur dioxide levels were recorded with details of weather, wind speed, stack heights, station load and sulfur content of the fuel. Background levels of 0 to 0.1 ppm were measured. Maximum concentrations beneath the plumes and downwind various distances from the sources ranged from 0 to 0.3 ppm. The ability of the CERL portable sulfur dioxide meter to measure microquantities of sulfur dioxide, and its usefulness as a rapid survey meter is illustrated. - PHEA

33. Davies, D.: Power stations and pollution. British J. Dis. Chest 56:171-175 (Oct.) 1962.

Modern power stations burn large quantities of coal. Though great attention is paid to the reduction in the discharges of smoke and grit, the policy now is to allow all the sulfur dioxide produced to enter the atmosphere. A modern power station is the best place for burning coal because it is clean and efficient but, on present knowledge, it should be located away from large center of population because of the sulfur dioxide produced. A defect in the Clean Air Act is that it deals with the emission of smoke but not of sulfur dioxide. In smoke control areas a reduction in the latter will result from an increase in the proportional use of gas and electricity, provided that in their manufacture sulfur dioxide is not discharged into the town's atmosphere. If this decrease is not achieved, the Clean Air Act may prove less beneficial to health than is now hoped. The implementation of the Clean Air Act is disappointingly slow. At a time when local authorities were being encouraged to accelerate their program, the Central Electricity Generating Board were pressing with extreme vigor a scheme that would have led to a considerable increase in sulfur dioxide levels in a large city. Though it was concerned with smoke and grit, the Board's attitude to sulfur dioxide was complacent in the extreme and it refused to accept that a health problem was involved. Evidence indicates that sulfur dioxide is a major factor in pollution and that every effort should be made to reduce its discharge into urban air together with other suspect materials. - APCA

34. Derge, K.: A system of analysis for air pollution control, particularly for exhaust gases of motor vehicles. VDI-Ztschft. 105:451-452 (April) 1963.

A system has been developed for exact and continuous determination of the content of nitric oxide, nitrogen dioxide, carbon monoxide, carbon dioxide, sulfur dioxide, hydrocarbons, and oxidants in air. It is suitable for obtaining data required for air pollution control. - English Sum.

35. Dudley, A.R.: How control over SO_2 emission reduces air contamination. Chem. Eng. Prog. 53:154-155 (March) 1957.

One additional source of SO_2 contamination is catalytic-cracking unit regenerator flue gases. The progress in reducing SO_2 contamination is summarized. The percentages shown are reductions based on the SO_2 contamination before the reduction program was initiated. Hydrogenation of gasoline, heating oil, and lube distillates reduced contamination by 3%. Clay treating of aromatic solvents resulted in a 15% reduction. Improved deasphalting of lube residuums through the use of higher solvent-to-oil ratios and more efficient deasphalting equipment permitted an additional 12% decrease. The total reduction achieved by eliminating or decreasing acid treatment was 30%. - APCA

36. Dyktor, H.G., and Goldston, L.N.: The effects of the steel industry on atmospheric pollution in the Cleveland area. Indust. Hyg. Newsletter 11:22-23, 1951.

The plan of survey and sampling procedures of a study of the air pollution load in the Cleveland area with the steel industry in operation and while the steel industry was closed by a strike are discussed. 546 air samples of 1 hour's duration were taken and analyzed and 120 filter disks were used for the determination of shade numbers, i.e., the soiling effect of air-borne dust. SO_2 during the steel strike ranged from 0-0.389 ppm, but only 1 sample was in the range of 0.290-0.389 ppm air in the southern area of the valley. After the steel strike, the range was from 0-0.489 ppm, but again only 1 sample was in the range of 0.390-0.489 ppm in the northern area of the valley. The mean SO_2 concentration for the strike period was 0.034 ppm and for the poststrike period 0.050 ppm. This increase is not significant. F-'s during the steel strike ranged from 0-50.0 $\mu g./m.^3$ or over, and there were 6 samples of > 50.0 $\mu g./m.^3$ air in the southern area of the valley. After the steel strike, the range was from 0-50.0 µg. or over, and there were 4 samples of >50.0 $\mu g./m.^3$, again in the southern part of the valley. The mean F^- concentration for the strike period was 11.59 and for the post-strike period 11.12 $\mu g./m.^3$. While the foregoing 2 contaminants do not seem to have been much affected by the absence or the presence of the steel-making activities, yet the latter had an appreciable effect on the soiling value of the air-borne dust. Based on a necessarily arbitrary unit, the over-all soiling range during the post-strike period was roughly 50% greater than during the strike. There is no doubt that the emissions of iron oxide and carbonaceous matter made their substantial contribution to the soiling effect of air-borne dust, especially in the northern half of the valley. - KB

37. Elemental sulfur. Extraction and reduction of sulfur dioxide from Roaster gases at Trail. Canad. Chem. & Process Indust. 26:138-139 (March) 1942.

This paper describes the sulfur dioxide disposal problem which existed in the plants of the Consolidating Mining and Smelting Co. of Canada Ltd., at Trail, B.C. The acidification, exorption and reduction processes are discussed.

38. Ely, S.B.: Report on Stationary Stacks. Bureau of Smoke Prevention, Pittsburgh Department of Public Health, 1948.

This report is a review of the work done during the year 1948 by the Pittsburgh Bureau of Smoke Prevention. It has to do with all the stationary stacks within the City of Pittsburgh. A separate report covering railroad smoke conditions is issued.

Sulfur dioxide is suggested as the likely toxic agent at the Donora disaster, and it is not considered likely that Pittsburgh could have such a disaster because of the small amount of sulfur dioxide emitted there.

An analysis is given in percentages for substances collected in cans throughout the Pittsburgh area during the year 1948. The highest concentrations of substances in the dust were sulfur trioxide, 18.9 percent; ferric oxide, 13.97 percent; silicon dioxide, 12.3 percent; and zinc oxide, 7.5 percent. The only item considered poisonous was lead oxide, which was only .005 percent of the total and therefore thought to be harmless. The sulfur trioxide represents all kinds of sulfur compounds so that gaseous sulfur compounds were a much smaller percentage. It is emphasized that all dust that falls in the cans is not directly from combustion, but much may be blown up from the ground.

Graphs are included showing results of dust collection comparing 1948 with 1938; a marked reduction is shown for the former. - BAAP

39. Ely, S.B.: 1949 Report on Stationary Stacks. Pittsburgh Dept. of Public Health, Bureau of Smoke Prevention, 1950, 13 pp.

This is a report on air pollution in Pittsburgh in 1949 and on the work of the Bureau of Smoke Prevention in reducing it. It includes reports on dustfall records, dust analysis, "smoke observations" or visibility measurements, the work of the Bureau in "controlling illegal coal" and enforcing the law's other provisions and comments from aviators on the great improvement in visibility above Pittsburgh. Estimates by various methods indicate that there was a 40 - 75% reduction in dirt in the city. Dustfall records showed a reduction of 79.0 - 61.6 tons/sq.mi. over downtown Pittsburgh, and reductions at nearly all the other points where measurements were taken. This dust came from other sources besides smoke. About 60% of its composition was SiO_2, Fe_2O_3, ZnO and SO_3. The amount of smoke, as judged by visibility, increased slightly from 1948-49, with a steady loss from 1945-48, but the smoke during the heating season decreased constantly. Statistics on complaints, cases tried and improvements in private stacks are included. - KB

40. Ely, S.B.: Air pollution in Pittsburgh. Arch. Indust. Hyg. & Occupat. Med. 3:44-47, 1951.

Samples of dust were collected each mo. in 8 cans (6" x 8" x 3') placed throughout the city on the roofs of buildings in 8 districts; the samples were then analyzed. The yearly average %'s for 17 mineral oxides are given for each station, and for all 8 cans for 1948 and for 1949. The values for the latter are: SiO_2-12.3 (1948) and 12.9 (1949); PbO-o.oo5 and 0.05; Fe_2O_3-13.97 and 13.2; Al_2O_3-2.9 and 3.2; TiO_2-0.7 and 0.4; Cr_2O_3-0.3 and 0.9; V_2O_5-0.09 and 0.5; NiO-0.007 and trace; Mn_2O_3-1.0 and 1.5; CaO-4.8 and 1.7; MgO-1.6 and 0.6; ZnO-7.5 and 13.6; SO_3-18.9 and 18.5; P_2O_5-trace and 0.03; CuO, MoO_3 and As_2O_3-traces for both years. The particle sizes ran practically uniform for the whole city: 75%-149μ, 15% - 44μ and 10% - < 44μ. The monthly analysis from each area is quite constant. A few items show the effect of location, e.g., high Fe_2O_3 near 2 steel mills. The monthly average dustfall for 1938, 1948 and 1949 are plotted. The yearly averages are also represented: 1938 - 60 tons/sq.mi., 1948 - ca.56 tons/sq.mi. and 1949 - ca.52 tons/sq.mi. The fixed C in the dust was plotted similarly. It indicates much better combustion in summer than in winter in 1938; by 1948 combustion was much improved and in 1949 it was not greatly different in winter and summer. The yearly averages are approximately: 1938 - 21%, 1948 - 15%, and 1949 - 13%. - KB

41. Ely, S.B.: 1952 Report of the Bureau of Smoke Prevention. Pittsburgh, Pa., Dept. of Public Health, 1952, 17 pp.

A reduction of 7.5% of total smoke in '52 over '51 and of 69.5% in '52 over '46, and a reduction of 58.8% of heavy smoke in '52 over '51 and of 93.0% in '52 over '46 was observed in Pittsburgh. Suspended matter, collected at 12 stations, averaged 0.55-0.90 mg./m.^{3} air/mo. for Sept.-Dec., 1952. Dustfall collected in 12 cans throughout the city averaged 51.6 tons/mi.^{2}/mo. compared with 52.9 in '51. The smoke inspectors' reports and the report on Pittsburgh railroads are also included. - KB

42. Ely, S.B.: 1952 Report of the Bureau of Smoke Prevention. Pittsburgh, Pa., Dept. of Public Health, 1953, 19 pp.

A digest of the Pittsburgh Smoke Ordinance No. 344 is given. The reduction of hours of total smoke in 1953 over 1946 is 69.4%, of heavy smoke - 94.4%. Dustfall collected in 11 cans showed an average of 50.7 tons/sq.mi./mo. throughout Pittsburgh.

A criticism of the can records is included. Cans are more or less a measure of weather conditions. Further, health is often more affected by fine particles, rather than by the large ones which contribute more to the weight in the cans. Actually the over-all averages for '51, '52 and'53 show little differences in values. Though the results of the electro-static precipitator are graphed, the values are not considered very reliable as not enough continuous samplings were obtainable. However, this method has the advantage of collecting finer particles than the cans do. Spectrographic analysis of the can deposits gave 20.11% SiO_2, 20.42% Fe_2O_3, 8.32% Al_2O_3, 2.32% MnO, 1.76% MgO, 4.58% CaO, 0.06% ZnO, 0.13% Cr_2O_3 and 0.05% SO_3. The inspectors' reports and the Pittsburgh railroads report are also included. - KB

43. Ely, S.B.: 1954 Report of the Bureau of Smoke Prevention. Pittsburgh, Pa., Dept. of Public Health, 1954, 20 pp.

A digest of the Pittsburgh Smoke Ordinance No. 344 is given. A comparison of the hours of moderate and of heavy smoke for each year from 1946-54 as observed by the U.S. Weather Bureau shows a reduction of heavy smoke in 1954 over 1946 of 98.7% and a reduction of total smoke of 85.8%. Dustfall collected in 12 cans throughout the city gave an average of 47.6 tons/sq.mi./mo. Spectrographic analysis of the can deposits showed 20.43% Fe_2O_3, 9.17% Al_2O_3, 20.38% SiO_2, 1.85% MnO, 1.67% MgO, 4.79% CaO, 0.06% ZnO, 0.09% Cr_2O_3 and 0.07% SO_3. The inspectors' report and the Pittsburgh railroads report are also included. - KB

44. Fielder, R.S., Jackson, P.J., and Raask, E.: Determination of sulfur trioxide and sulfur dioxide in flue gases. J. Inst. Fuel 33:84-89 (Feb.) 1960.

The apparatus described is easy to operate, compact, and portable. Measurements can be made at an average rate of 1 every 15 to 20 min. The turbidimetric technique is simple and is more sensitive than previously published methods, its precision, at similar concentrations, is comparable with the best of these. The successful use of this apparatus and analytical procedure in some thousands of measurements in power stations have shown that this is a convenient and reliable test method for the determination of sulfur oxides in flue gases in the lower temperature passes of boiler plant. The simplicity of the apparatus and the analytical method have made it possible to establish, for the 1st time, the determination of sulfur trioxide in flue gas as a routine technique of power station chemistry. - APCA

45. Fielder, R.S., and Morgan, C.H.: An improved Titrimetric method for determining sulfur trioxide in flue gas. Anal. Chim. Acta 23:538-540 (Dec.) 1960.

The measurement of SO_3 concentrations in the range 0-50 ppm. v/v in the presence of 2000-3000 ppm. v/v of SO_2 is usually carried out in 2 stages: (1) quantitative absorption of the SO_3 from a sample of flue gas in an aqueous solution of isopropanol which inhibits oxidation of SO_2, (2) determination of µg. quantities of SO_3 in the aqueous isopropanol. In most techniques described, sulfate in the aqueous isopropanol has been determined turbidimetrically; this technique possesses limited sensitivity and precision, and is rather time-consuming. The titrimetric method is quicker, more precise, and more sensitive than the turbidimetric method, which it would replace with advantage; it requires less manipulation and the reagents used are stable over long periods. The titrimetric procedure could be used to complete the flue gas analysis at the sampling site and is suitable for routine application to industrial plant. - APCA

46. Flint, D., Lindsay, A.W., and Littlejohn, R.F.: The effect of metal oxide smokes on the sulfur trioxide content of combustion gases from fuel oils. J. Inst. Fuel 26:122-127 (Sept.) 1953.

Quantitative data were obtained on the influence of various additives to the fuel burned as a method of decreasing the quantity of sulfur trioxide. Measurements on the gases from the heavy fuel oil treated with (1) soda residue, (2) calcium residue, and (3) commercial zinc naphthenate showed that the last alone was successful in decreasing greatly the amount of SO_3. Under good combustion conditions the dew point indicated no SO_3 when oil containing 0.14% zinc was burned. With 0.07% zinc the amount of SO_3 was still very low, as shown by a dew point of 160°F. - Cond. Authors' Sum.

47. Formation and control of sulfur oxides in boilers. Committee TA-9, Power boiler equipment information. J. APCA 12:567-591 (Dec.) 1962.

In the combustion of fuels, sulfur is converted essentially completely to SO_2. A small percentage is further oxidized to SO_3 by various mechanisms which are not completely understood; these processes are discussed in the text. Possible control measures are discussed. Removal of sulfur from fuels is limited by economic considerations. Removal of SO_2 from stack gases is technically possible by certain processes, but no economically feasible processes are available. Removal of SO_3 from stack gases by means of additives has been accomplished in some cases. Economic justification may be provided by alleviation of corrosion and deposit problems. - Authors' Abst.

48. Frankenberg, T.T.: Air pollution from power plants and its control. Combustion 34:28-31 (Feb.) 1963.

Removal of sulfur from coal before burning, sulfur oxides from combustion gas, work on elimination of nitrogen oxides, and changes in methods of combustion are discussed. The principal new factor affecting air pollution from power plants and its control is the shift to larger individual units, and larger total plants. The selection of stack heights has been studied and the power industry has moved to maintain community relations by disposing of large quantities of gases from new plants. - APCA

49. Gay, E.J.: Sulfur in automotive gasoline. A review of the work of the Coordinating Research Council, Inc. (U.S.A.) in regard to the sulfur content of gasoline (for automotive vehicles) and the effect of sulfur on engine operation. Proceedings 3rd World Petroleum Congress, The Hague, 1951, Utilization of Oil Products, Section VII, pp. 261-269.

This paper presents the results of cooperative work to investigate the effects of sulfur in automotive gasoline on engine operation. The American Petroleum Institute and the Society of Automotive Engineers jointly supported this test program under the sponsorship of the Coordinating Research Council. A large number of companies, including the automotive and petroleum industries and several fleet owners, participated directly in laboratory and field service tests. Sixty-two vehicles completed service tests at seven test sites wherein the effect of two gasoline sulfur levels - roughly 0.10% and 0.25% - on engine wear and cleanliness were compared. A total of one and one-half million road test miles, ranging from light to heavy duty operation, were accumulated.

The field test data reported herein show that the influence of up to 0.3 percent sulfur in gasoline, as compared to gasolines of 0.1 percent sulfur and lower, may vary from no effect under continuous operation at normal engine temperature, to a pronounced effect on cylinder and ring wear, under some operating conditions. This increased wear, to a considerable extent, does not check general field service experience in the United States, even in the areas where high-sulfur gasolines have been widely used.

It is the opinion of CRC that there is ample material for study in the formal report of the work on sulfur in automotive gasoline. The engine manufacturer and petroleum refiner may wish to do further work with their own products, using their own test facilities, following the several avenues of investigation which are open to both. - Author's Sum.

50. Geid, F., and Slavik, I.B.: Application of sound in ridding the atmosphere of noxious gases. Akust. Zhur. Akad. Nauk, SSSR 5:243-244, 1959.

It is well known that a gas can be cleansed of injurious solid admixtures, such as dust or soot, by means of the coagulation of these impurities under the action of sound. An instance is cited where it was possible to clear the air of sulfur gas (SO_2) in this way. Using ammonia gas (NH_3) as the reagent, in the presence of moisture the sulfur gas reacted to form solid ammonium sulfate. An instance is cited in which Hartmann whistles set for a frequency of 8000-11000 cy./sec. were arranged in 4 rows and small vessels with ammonia were placed under the whistles. After several min. of operation a deposit of sulfur products was obtained and the air even in the immediate vicinity was rendered harmless. The degree of purification of the air depends on the frequency and strength of the sound field. The shortcoming of the Hartmann whistles is their low efficiency. From the practical point of view it is more suitable to utilize sound radiators of the siren type. These generators can be applied advantageously to heat-generated electrical power plants, both for ridding the air of cinders, which contaminate the air as a result of the burning of low-caloric and soft coal, and for ridding the atmosphere of sulfur gas. - APCA

51. Gilardi, E.F., and Manganelli, R.M.: A laboratory study of a lead acetate-tile method for the quantitative measurement of low concentrations of hydrogen sulfide. J. APCA 13:305-309 (July) 1963.

This paper reports laboratory studies the purpose of which was to evaluate, on a quantitative basis, a similar lead acetate-tile procedure. The effect of H_2S exposure, air turbulence, humidity, and several possible interferences upon the rate of formation of colored lead sulfide on the tile surface, was investigated. The fading of the lead sulfide color, both in indoor controlled experiments and under outdoor exposure conditions, was also studied.

52. Goksøyr, H., and Ross, K.: The determination of sulfur trioxide in flue gases. J. Inst. Fuel 35:177-179 (April) 1962.

A simplified method has been developed for the rapid determination of sulfur trioxide in flue gases. The sulfur trioxide is retained by condensation as sulfuric acid in a certain temperature range below its dewpoint. The collecting apparatus is easy to operate and allows gas sample rates as high as 10 liters/min. to be achieved. The sulfuric acid is estimated by a simple acid-base titration. Thus in less than 15 min., a complete determination may be carried out and the apparatus prepared for the next test. The method described has been proved reliable and more convenient than the methods previously used. - APCA

53. Griswold, S.S.: Sulfur dioxide: Perennial pollution problem. West. Oil Refining 59:8-9, 1962.

A brief survey of SO_2 emission in Los Angeles County. Data for 1962 indicate a substantial SO_2 increase over 1961.

54. Harlow, W.F.: Formation of sulfuric acid in boiler flue gases. Trans. ASME 80:225-234 (Jan.) 1958.

Reference made to mechanism for formation of sulfuric acid in flue gases of modern boiler plants by process of surface catalysis; continuing controversy on question as to causes; further work on subject, including tests which leave explanation in no reasonable doubt; effect on sulfuric acid formation of various surface treatments of heating surface both metallurgical and chemical. - PHEA

55. Hartough, H.D.: Chemistry of the sulfur compounds in petroleum. In: Advances in Petroleum Chemistry and Refining. Interscience Publisher Inc., New York, 1960, vol. 3, chapt. 9, pp. 419-481.

Although all crude oils are recognized today to contain sulfur in amounts varying from a few tenths of a percent to nearly 20% by weight, the discovery of oil in 1859 in Pennsylvania consisted of "sweet" crudes exceptionally low in sulfur, and its presence was either not known or at least not reported until much later. It was not until about a quarter of a century later, when "sour" crudes were discovered in Ohio, that sulfur began to be recognized as a serious problem. Soon the first study and identification of sulfur compounds in petroleum was undertaken and in 1891, Mobery published an article on the isolation of a series of sulfides from Ohio crudes. While none of these compounds were positively identified, the presence of sulfides was held to be well established. In the forty years following Mobery's publication, very little work on the identification and estimation of sulfur compounds was completed. This led Sachanen to surmise in 1945 that "quantitative data on the distribution of sulfur compounds in crude oils are entirely lacking. Our knowledge of the individual compounds in crude oils and distillates is very meager. The knowledge of organic sulfur compounds is, so far, much behind that of hydrocarbons or even oxygen compounds."

A Bureau of Mines publication RI no. 4060, published in 1946, states in part: "The sulfur in petroleum has been defined in one paper as consisting of hydrogen sulfide, free sulfur, and organic sulfur compounds. This division, although accurate, gives no indication of the structure of the organic sulfur compounds which comprise most of the sulfur in petroleum."

Thus was the state of the literature and the technology in 1948 when the American Petroleum Institute inaugurated Research Project 48 to study "The Production, Isolation, and Purification of Sulfur Compounds and Measurement of Their Properties." Since 1948, API Research Project 48 has turned out a mass of work second to none in the field.

It will be noted that every possible sulfur compound that could occur in the lower boiling range does occur except the unstable cyclic sulfides, thiacyclopropane and thiacyclobutane. Through work on the higher residues boiling above 200°C., the principal products appear to be cyclic and principally aromatic in nature. In 1956, Richter et al. reported the isolation and identification of thianaphthene from Santa Maria crude. Vacuum techniques with the mass spectrograph has led the workers of the API Research Project 48 and cooperating petroleum research laboratories to the conclusions that the sulfur compounds in crude oil residues are almost entirely cyclic in nature and are, for the most part, condensed thiophenes of almost every series, e.g., thianaphthene, dibenzothiophene, naphthothiophenes, benzonaphthothiophenes, etc. Thienothiophenes (thiophthenes) have not been isolated or identified as such but there are indications of condensed molecules containing more than one thiophene nucleus.

56. Heimendahl, P.V.: Fly ash and SO_2 emission and combustion residues of West German power stations. Result of a questionnaire of the V.G.B. of 1962. Mitt. V.G.B. No. 87, pp. 409-415 (Dec.) 1963.

Results of an evaluation of questionnaires indicate, for the period 1952-1962, that due to the decrease in coal consumption per kWh generated, and partly due to the installation of improved dust separators, the emission of fly ash from power stations has been reduced to 27% in spite of an 130% increase of power generation. However, the emission of SO_2 doubled. The member works were requested to indicate whether they agreed using low sulfur content fuels in such areas with smog formation. The results show that the total SO_2 emission in the Ruhr area, the most severely affected region, would only be reduced by 5%. A summary of the amounts of dumped and utilized cinders, slag and ash produced in power stations are tabulized.

57. Hill, G.R., Thomas, M.D., and Abersold, J.N.: High stacks overcome concentrations of gases. Mining Congr. J. 31:21-25 and 34, 1945.

The use of high stacks emitting gases at high temperatures has done away with objectionable concentrations of sulfur dioxide at many smelters and has materially reduced them at others. This paper concerns itself with measurements of sulfur dioxide taken in the farming areas surrounding certain plants and with some other related data.

The baghouse for filtering non-acid smoke, and the Cottrell plant for electrical treatment of acid smoke streams have been improved until today the losses of solids from smelters are quite negligible. Neither the baghouse nor the Cottrell plant has any effect, however, on the gas, sulfur dioxide. - Authors' Sum.

58. Hoffmann, F.W., Ess, R.J., Simmons, T.C., and Hanzel, R.S.: The desulfurization of mercaptans with trialkyl phosphites. Communications to the Editor 78:6414 (Nov. 12) 1956.

The attempted extension of the transesterification of triethyl phosphite with aliphatic alcohols to mercaptans resulted in the formation of triethyl thionophosphate with simultaneous conversion of the alkanethiol to the corresponding alkane according to the equation $(C_2H_5O)_3P + RSH \quad (C_2H_5O)_3PS + RH$. This unusual desulfurization reaction proceeds practically to completion at reflux temperature during several hours, or at a slower rate at room temperature, and is effectively catalyzed by ultraviolet irradiation.

Thus, a mixture of 83 gr. (0.5 mole) of triethyl phosphite (previously distilled from sodium) and 73 g. (0.5 mole) of n-octyl mercaptan in a Pyrex flask fitted with a 24-in. fractionating column was irradiated with a General Electric 100-watt S-4 bulb at a distance of 5 inches from the flask. After 6.25 hours of irradiation, the mixture was distilled to give 50.3 g (88%) of octane, b.p. 122.0-124.5°, $n^{25}D$ 1.3951-1.3959 (b.p. 125.59°, $n^{25}D$ 1.3953) and 90.9g. (0.459 mole) of triethyl thionophosphate, b.p. 45° (0.50mm), $n^{20}D$ 1.4461 (b.p. 105-106° (20 mm.), $n^{20}D$ 1.4480, calcd. $n^{25}D$ 1.4460).

Likewise, 83 g. (0.5 mole) of triethyl phosphite and 62 g. (0.5 mole) of benzyl mercaptan were treated in an identical manner to give 43.1 g. (93.6%) of crude toluene, b.p. 90-110°, $n^{25}D$ 1.4945 (110.56°, $n^{20}D$ 1.4963, calcd. $n^{25}D$ 1.4942) and 94 g. (95%) of crude triethyl thionophosphate b.p. 55° (0.9 mm), $n^{25}D$ 1.4461-1.4500, contaminated with some benzyl mercaptan, b.p. 194°, $n^{25}D$ 1.5715.

Preliminary results show that a wide variety of thiols undergoes the reported desulfurization reaction with triethyl and other trialkyl phosphites. The results of a current investigation of the scope and mechanism of the reaction will be reported later.

59. Hoffman, W.: New insight into the combustion of sulfur-containing fuel oil. Energie 12:491-494 (Nov.) 1960.

Recent investigations by the author and others lead to these conclusions: (1) The SO_3 content of the flue gas does not depend on the S content of the oil, but on combustion conditions and all factors influencing combustion; coarse atomization with good mixing of air produces less SO_3 than fine atomization with bad mixing; (2) The term sulfuric acid dew point should be replaced by beginning sulfuric acid deposition; (3) Corrosiveness depends on the amount of sulfuric acid formed during combustion. No relationship exists between sulfuric acid content of the flue gas and S content of the oil; (4) The influence of a higher or lower content of sulfur in the fuel and the corrosiveness of the flue gas apply only when the combustion is imperfect or incomplete; (5) Chimney emission of soot and smoke is a problem of burner and furnace design. - APCA

60. Holmes, J.A., Franklin, E.C., and Gould, R.A.: Effect of sulfur dioxide on vegetation. Report of the Selby Smelter Commission. USBMB 98, 1915.

Several fresh, vigorous plants (arbor vitae, grapevine, peach limb, and apple limb) were exposed experimentally to the action of sulfur dioxide mixture. No appreciable damage was observed except on the grapevine, the leaves of which were bleached.-BAAP

61. Horne, W.A., and McAfee, J.: Hydrogenation of petroleum and its fractions. In: Advances in Petroleum Chemistry and Refining. Interscience Publishers, Inc., New York, 1960, vol. 3, chapt. 5, pp. 193-277.

A great many publications have been devoted to the hydrogenation of crude petroleum and its fractions, from gas to coke. With such an acknowledged versatility and seemingly unlimited variety of applications, it is only natural that processing with hydrogen has assumed a position of substantial importance in petroleum refining.

Hydrogenation, for this discussion, is not limited to the saturative addition of hydrogen to olefinic or aromatic bonds, but includes such reactions as cracking, desulfurization, denitrogenation, deoxygenation, and demetalization in the presence of hydrogen which usually take place at elevated temperature and pressure, and in the presence of a catalyst. Authors discuss the historical development, trends and projections in Europe and the United States, and some of the more recent developments in the fields of chemistry, catalysts, and engineering. The principal effects of hydrogen treating, alternate sources of hydrogen, and process applications which have been developed for upgrading of whole crude and all its fractions are summarized briefly. These applications, some of which are commercial, all utilize hydrogen as a means of improving the quality of various fractions of petroleum or intermediate process streams, including gas, virgin and cracked gasolines, naphthas, middle distillates, cracking stocks, lubricating oils, waxes, residuals, and coke. 82 references.

62. Jackson, A., and Solbett, J.M.: Sulfuric acid plant: Tail gas treatment. Soc. Chem. Indust. 42:1304-1311 (Oct. 15) 1955.

Emission of sulfur oxides e.g., unreacted SO_2 and unabsorbed SO_3, from sulfuric acid plants considered from point of view of air pollution; ammonia scrubbing method of tail gas is discussed and results achieved. Bibliography. - PHEA

63. Jarvis, W.D., and Austin, L.G.: Routine surveys of atmospheric pollution by dust and sulfur dioxide around power stations of the central electricity authority. J. Inst. Fuel (London) 30:435-436 (Aug.) 1957.

The paper gives details of a number of atmospheric pollution surveys which have been carried out by the Central Electricity Authority to observe changes in the level of dust deposition and sulfur dioxide pollution in the neighborhood of modern power stations when the power stations were put into operation. The results so far obtained show that the increase in the rate of dust deposition within a radius of two miles of a power station is small. The average concentration of sulfur dioxide at ground level has shown a trend towards a small increase with increasing power station output, but changes which occurred in the background levels of sulfur dioxide concentrations during the period of the surveys do not allow a significant conclusion to be drawn. The results suggest that other methods of measuring small changes in the concentration of sulfur dioxide should be considered. - Authors' Abst.

64. Jedrzejowski, J.: Effects of a chemical plant on the environment. Gaz. Woda i Tech. Sanit. (Warsaw) 33:240-244, 1959.

The emission into the atmosphere of sulfur compounds discharged from a plant manufacturing artificial silk, is discussed on the basis of a study of the wind effects on distribution of sulfur components in the atmospheric air. Measurements were made at distances up to 10 km. from the plant chimney which was at a height of 100m. Proper control of air pollution is considered to be possible only with the use of absorbers. Recommendations are given for calculating the control measures as well as formulas and procedures of calculation. - APCA

65. Jensen, M.L., and Nakai, N.: Sources and isotopic composition of atmospheric sulfur. Science 134:2102-2104 (Dec. 29) 1961.

Studies on the relationship between variations in isotopic composition of sulfur and the genesis of sulfide minerals have led to encounters with the complexities of the biogeochemical cycle of sulfur. One significant portion of this cycle is the role of sulfur in the atmosphere. Sulfur occurs in the atmosphere predominantly as SO_4--in aerosols and in SO_2 and H_2S gas. The 2nd form and in all probability the 3rd, is oxidized to SO_3, which in the presence of moisture forms hygroscopic SO_4--nuclei. In nonindustrial areas the prime source of SO_4--in rain and snow is atmospherically oxidized H_2S that is produced along coastal belts by anaerobic bacteria. The o S^{34} analyses of atmospheric SO_4--vary from +3.2 to +15.6/mil. in contrast to 20.7/mil. for sea water SO_4--. Contrary to previous studies based on $Cl^-/SO_4^{--}$is a minor source. - APCA

66. Jötten, K.W.: The question of injury to the neighborhood by exhaust fumes and gases of industrial establishments. Arch. Hyg. u. Bakteriol. 125:239-272, 1941.

The author reports on several of his investigations to settle controversies on the alleged harmfulness of industrial waste gases. In all instances, numerous air samples were collected under various meteorologic conditions and at various distances from the source of contamination. The physiologic action of the respective substances detected on analysis is discussed. (1) Smoke, given off by a burning slag pile, was found to contain: mercaptans, H_2S, SO_2, and NH_3 (no concentrations are given). Protests that it represented a hazard for persons living at 65 m. distance were rejected, since the smoke was immediately diluted by the air and since on examination, no pathologic changes were detected in these persons. (2) Another slag pile gave off smoke containing SO_2, present at 10 ppm at the slag pile and in traces near the living quarters of the workers. A marked disturbance in the chlorophyll formation was observed in the plants growing near-by. It was advised to discontinue the use of the living quarters. (3) Construction workers were exposed, during work, to the inhalation of smoke, noticeable by a pungent smell and a severe effect on the conifers growing close-by. Analyses of air samples revealed the presence of H_2SO_3 at the following concentrations (mg./l. of air): 0.029-0.30 at the working place and 0.125 near the workers' quarters. 2 groups of construction workers, 13 and 24, respectively, ranging in time of employment from 2 weeks to 10½ years, were questioned, and blood samples were taken. The findings included the symptoms typical for the action of SO_2 and high values for Hb (range: 72-126%) and for lymphocytes (22-54%). These findings resulted in an improvement of the hygienic control and the removal of the workers from the present quarters. (4) In another instance, objections to the construction of a galvanizing plant, based on fear of its allegedly injurious effluents, were rejected. In previous investigations in 2 different galvanizing plants, the author had found no effect on workers with exposures extending over "several decades" and had detected only 0.149 and 0.217 mg. Zn/l. of air, respectively, at the Zn vats and traces at a distance of 3-40 m. (5) The investigation of the harmfulness of exhaust gases given off by a gas-producing plant included three main studies: (a) 23 persons, selected at random from workers and employees of the plant, had neither complaints nor objective signs of poisoning; neither had the inhabitants of the houses in the vicinity of the plant. (b) Air samples of 25 l. each were analyzed for: CO_2, CO, NH_3, HNO_2, H_2SO_3, H_2S, CS_2, C_2H_2, $C_3H_5^-$, $(CN)_2$ and C_6H_6. Some substances were present in traces, none at concentrations injurious to health. (c) Mice and rabbits, after having inhaled air from the collected samples, showed no changes in physical condition or in the composition of their blood. Also, this air, made to flow through the blood of sheep, did not affect it in any way. It was concluded from the above results that the effluents of the plant, even though malodorous, did not represent a hazard to the health of the exposed persons. - KB

67. Johnson, C.M., and Nishita, H.: Microestimation of sulfur. Anal. Chem. 24:736-742 (April) 1952.

Sulfur-deficient plant material may contain as little as 0.5 p.p.m. of sulfate sulfur. The soluble sulfate of soils giving rise to sulfur-deficient plants may be as low as 0.1 p.p.m. In studies of the sulfur nutrition of plants under conditions where growth is limited by their sulfur supply, often only small amounts of plant material are available for analysis. It was desirable to develop rapid and accurate methods for the determination of total sulfur and sulfate sulfur that would be relatively specific for sulfate sulfur in the presence of organic sulfur compounds. Sulfate is digested at 115° C. with a reducing mixture composed of hydriodic acid, formic acid, and red phosphorus. The resulting hydrogen sulfide is determined spectrophotometrically as methylene blue. From 1 to 300 micrograms of sulfate sulfur may be determined in 1 to 2 hours with a precision of 2 to 5% without interference in the presence of cystine, cysteine, glutathione, methionine, and taurine. Total sulfur may also be determined after the sample is ashed. The method permits rapid determination of sulfate sulfur or total sulfur in samples containing as little as 1 microgram of sulfur. It should prove of value in studies of sulfur metabolism in plant and animal biochemistry and physiology. - Authors' Abst.

68. Johnstone, H.F., and Sing, A.D.: Recovery of sulfur dioxide from waste gases. Design of scrubbers for large quantities of gases. Indust. Eng. Chem. 29:286-297, 1937.

Measurements of the rates of absorption and heat transfer and of the resistance to gas flow were made for a number of arrangements of (a) vertical smooth plates, (b) vertical corrugated plates, with horizontal corrugations, set at various spacings and with different depths and frequencies of corrugations, (c) grid surfaces with various channel dimensions and arrangements, and, for comparison, (d) ordinary tower packing such as Raschig rings, spiral rings, and wire helices. The absorption data on sulfur dioxide by alkaline solutions, and on ammonia by acid solutions were found to be accurately correlated with heat transfer data by the Chilton-Colburn equation.

Taking all factors into consideration, the most desirable packing of those studies for handling large quantities of flue gases is composed of grids with 1.5-inch channels and with individual sections from 4 to 6 inches high. - Authors' Abst.

69. Johnstone, H.F.: Sulfur dioxide. Indust. Eng. Chem. 34:1017-1028 (Sept.) 1942.

Recent developments in the chemistry of sulfur dioxide and of its derivatives are reviewed. Recovery from dilute smelter gases is now accomplished on this continent as well as in Europe. Other sources of sulfur dioxide and sulfur from waste gases are surveyed. The uses of sulfur dioxide per se and as a raw material for other industrial products is discussed both from the standpoint of providing a market for the by-product gas and as a cornerstone of the chemical industry.

70. Johnstone, H.F.: Technical aspects of the Los Angeles smog problem. J. Indust. Hyg. & Toxicol. 30:358 (Nov.) 1948.

The southwest and west winds carry the dust and fumes of the industrial district over the city. At times the air becomes stagnant, and low visibility, high temperature, and humidity increase the irritation to the eyes, nose and throat. The sulfur dioxide concentration is usually considered a good index of the degree of industrial contamination of the air. There are some indications that sulfur dioxide may contribute directly to smog formation. Sulfur trioxide and sulfuric acid contribute to mist formation. Removal of sulfur compounds from waste products is difficult. About the only forms in which sulfur can be used as a raw material or chemical agent in any quantity are elemental sulfur, hydrogen sulfide, sulfur dioxide and sulfuric acid. Many of the smog-contributing industries were started during the war, when smoke-eliminating equipment could not be made and when air pollution control was lax. This must be remedied and new methods employed to alleviate the smog situation. - BAAP

71. Johnstone, H.F., and West, W.E., Jr.: Recovery of sulfur dioxide from waste gases and ammonium sulfate manufacture. (To Texas Gulf Sulfur Co.) U.S. 2,810,627 (Oct. 22) 1957.

SO_2 is recovered from waste gases such as those from the combustion of coal by scrubbing with aqueous ammoniacal solution to give an effluent containing $(NH_4)_2SO_3$ and NH_4HSO_3. The effluent is treated with air or pure O to produce $(NH_4)_2SO_4$ and SO_2. The SO_2 is stripped from the solution and the $(NH_4)_2SO_4$ is crystallized from the residual solution. - APCA

72. Junge, C.E.: Sulfur in the atmosphere. J. Geophys. Research 65:227-237 (Jan.) 1960.

In unpolluted areas sulfur occurs primarily in 3 compounds, SO_4 = in aerosols and SO_2 and H_2S as gas. Sources of SO_4 = are the ocean, the soil, and the oxidation of the gaseous compounds. As measurements in polluted and unpolluted areas indicate, most of the H_2S seems to be natural. In unpolluted air in the northeastern part of the U.S., both gases have approx. equal concentrations. The chemistry of the conversion of these gases to SO_4 = is discussed. It is concluded that industrial sulfur is removed from the atmosphere before it spreads to polar regions. This is consistent with estimates of the residence time of about 5 days for SO_2 and about 40 days for total sulfur. In view of the considerable amounts of industrial sulfur, it is possible that the global sulfur cycle is not closed and that most of the excess sulfur in river waters is of anthropogenic origin and will stay in the ocean. - APCA

73. Jutze, G.A., and Tabor, E.C.: The continuous air monitoring program. J. APCA 13:278-280 (June) 1963.

As required by recent legislation, the Public Health Service has extended its program of investigations of the role of auto exhaust in air pollution. One phase of this program is a study, in major American cities, of the concentrations of various gaseous air pollutants that may be related to auto exhaust. This is the Continuous Air Monitoring Program (CAMP). The cities of Chicago, Cincinnati, New Orleans, Philadelphia, San Francisco, and Washington were selected to participate in this investigation. Los Angeles with existing equipment and facilities, is participating on a co-operative basis. In addition, a study at Wayne State Univ. in Detroit, sponsored by the LMBS of the Div. of Air Poll., will provide comparable data. - Authors' Sum.

74. Karymov, M.: Pollution of atmospheric air by waste products of abrasive industry. Leningrad, sanit. gigienicheskii medit. inst. Trudy (Leningrad) 44:65-72, 1958.

Abrasive industry works may become a considerable source of contamination of the air because of dusts containing free SiO_2 and sulfurous gases. At the factory under examination the quantity of accumulated dust exceeded the average indexes of air contamination for cities, 1.5 to 5 times that for dwelling areas; 1.7 to 3 times that for industrial areas. The max. observed single concentrations of dust and sulfurous gas exceeded the tolerable limit range in the radius of 100 m., dust by 1.2 to 61.4 times and sulfurous gas from 1.7 to 8.4 times. The concentration of free SiO_2 in the ashes of accumulated dust for the whole period of investigation averaged up to 40.4% within a radius of 250 m. and up to 23.3% in a radius of 1000 m. When sanitary requirements are not observed, waste products of abrasive factories may exert a harmful influence upon the health of the surrounding population and, particularly, may increase the illness rate among children living in the factory area. Results of investigations established that occurrences of eye trauma in the streets neighboring factories are much more frequent than in those districts situated farther away. - APCA

75. Katin, A.: Air pollution from oil refineries and measures of control. Luftverunreinigung pp. 39-51 (Dec.) 1962.

There are a number of components of incomplete combustion in the air surrounding oil refineries, such as SO_2, hydrocarbon, hydrogen sulfide, mercaptane and others. Sulfur dioxide emitting from various furnaces can be controlled according to amount, and concentration. Threshold limits can be observed. Other emissions appear in such low concentrations which can be noticed by its odor, however, cannot be measured. Complaints were received during the past years about such odors typical in the vicinity of oil refineries. Methods have to be found for the measurement of odors and to establish limit values. Air pollution can be eliminated or considerably reduced by installation of proper equipment in the plants. These problems are relatively new to oil refineries and such equipment is therefore not generally available.

Before the war oil was refined generally at the place of origin, or in the nearest harbor, in sparsely populated areas. But lately large oil refineries have been established in densely populated areas already polluted by other industrial emissions. For this reason every effort has to be made for lowering these emissions considerably. This paper contains a survey of the oil industry from the air pollution point of view. Short technological descriptions of methods used in fuel refineries, the sources of air pollution and its control are being described. Emphasis is on odor control and control of sulfur dioxide emissions.

76. Katz, M.: Sources of pollution. Proc. Second Nat. Air Poll. Symposium (May 5-6) 1952, pp. 95-105.

This paper discusses the Detroit-Windsor International Program. The climatological conditions and degree of contamination of the Detroit River area, and the relation of environmental data to the Public Health Survey. There are eight tables.

77. Katz, M.: Application of diffusion theory to dispersion of stack gas in the atmosphere. Meteorol. Abstracts & Bibliography 5:1012-1013 (Sept.) 1954.

Data on concentration of SO_2 at various distances downwind from the Trail, B.C., smelter under different atmospheric conditions, and of dispersion of SO_2 fumes at distances of 18.5 to 58 miles from Copper Cliff, Ontario (Sudbury District) are analyzed and used to test the Bosanquet-Pearson and the Sutton diffusion equations. The latter gives the best correlation between observed and computed values. Even so, the concentration of gases at distances 6 miles from Trail, B.C., are often 4 to 5 times the theoretical maximum. Reasons are suggested for this discrepancy. The history of the subject, the theory and methods of observations and extensive tables of data are included.

78. Kelly, F.J.: Sulfur Production and Consumption in Eight Western States: Arizona, Colorado, Nebraska, New Mexico, North Dakota, South Dakota, Utah, and Wyoming. USBMIC 8094, 1962. 85 pp., including bibliography.

The purpose of this survey is to review the demand for sulfur and primary sulfur compounds that draws upon the natural resources of the region, to discover opportunities for better use of these resources, and also to analyze and evaluate the patterns of consumption, sources of supply, and other factors that affect the demand for these mineral products. While this survey stresses the economic and marketing phases of the industry, a complementary report (Wideman, F.L.A.: A Reconnaissance of Sulfur Resources in Wyoming, Colorado, Utah, New Mexico, and Arizona. Bureau of Mines Inf. Circular 7770, Jan. 1957, 61 pp.) emphasizes the resources of sulfur in Wyoming, Colorado, Utah, New Mexico, and Arizona.

In this report the term "sulfur" not only includes elemental and native sulfur but also includes sulfur compounds such as iron sulfide (pyrite), hydrogen sulfide, sulfur dioxide, and sulfuric acid.

79. Kirov, N.Y.: Sulfur in oil fuels. Its effect on combustion. J. Inst. Fuel 35:426-431 (Oct.) 1962.

High-sulfur oil fuels give rise to emissions of acidic smuts and acid condensates. The oxides of sulfur are probably the most harmful of the air pollutants from combustion gases. They are harmful to health, plant life, buildings, metals, and fabrics. Sulfur trioxide in the combustion gases plays an important role in the process of soot flake formation. It condenses on the fine free carbon particles formed during combustion and causes them to agglomerate to large flakes. Various techniques and remedial measures are discussed which have been developed to study and control these problems in plants burning residual oil fuels. The bibliography contains 56 references. - APCA

80. Kishko, IA.G.: Air pollution by sulfur dioxide and chlorine gas in the city of L'vov. Gig. i Sanit. 27:77-79 (Jan.) 1962.

In 1959 air pollution was investigated in the housing, industrial (machine-building and light industry), and park districts of the city of L'vov and in the area near the railroad station. Tabulated data on the content and concentration of sulfur dioxide and chlorine gas in the atmospheric air are given and their dependence on humidity is shown. Sulfurous gas was found in the atmospheric air of the city in very small amounts; from 0.008 mg./m.^{3} in the park area to 0.115 mg./m.^{3} in the area of the railroad station square. This is many times less than in other cities and considerably below the permissible max. concentration limit. The concentration of chlorine gas in the air is highest in the railroad station area (0.051-0.061 mg./m.^{3}) and lowest in the city park area (0.022-0.024 mg./m.^{3}). This also is below the permissible max. concentration limit. Conversion to the use of gas, instead of coal, is a determining factor in the fight to improve the sanitary condition of the air of cities. The concentration of sulfur dioxide was found to increase with rising relative humidity; the chlorine content was highest in the atmospheric air at a relative humidity of 40-80%. - APCA

81. Kriege, O.H., and Wolfe, A.L.: The spectrophotometric determination of sulfur in iron alloys. Methylene blue method. Talanta 9:673-678 (Aug.) 1962.

Sulfur is determined in iron alloys by evolution as hydrogen sulfide, followed by reaction with N,N-dimethyl-p-phenylene-diamine and iron^{III} to form methylene blue, which is measured spectrophotometrically. Replicate results are reported for acid soluble metal samples containing 0·3-230 ppm of sulfur. An evaluation of the accuracy of the methylene blue procedure was made using radiotracer techniques. - Authors' Abst.

82. Kropp, E.P., and Simonsen, R.N.: Scrubbing devices for air-pollution control. Paint Oil Chem. Rev. 115:11, 14 & 16, 1952.

Three main sources of air-pollution are considered: acid treating of lubricating oil stocks (I) in which large quantities of SO_2 and some SO_3 are evolved, grease manufacture (II) in which unpleasant smelling fatty acids and H_2S are possible contaminants, and asphalt manufacture (III) in which the disagreeable portion of the fumes consist of hydrocarbon aerosols and vapor. Studies were made of these three process sources to determine a means of minimizing the nuisances. The batch nature caused release of contaminants to be periodic; the total amounts were not excessive and were not enough to warrant economical recovery. The problem was one of converting the offending material into a form satisfactory for disposal. Low-pressure spray towers were ineffective in removing SO_2 from I and a survey of other scrubbing devices was made. An experimental fog-filter unit is described and previous workers' conclusions that a high degree of atomization of the scrubbing medium is necessary in cases of difficult absorption, was confirmed. A gauge pressure of physical dimensions and rated capacity of the filter unit are tabulated. A 3% solution of soda ash in water was used as the scrubbing medium. At a concn. of 10,000 p.p.m. of SO_2, an air rate of 1000 cu.ft. per min. and a spray rate of 20 gal. per min., the SO_2 concn. was reduced to 1 p.p.m. The same equipment was used experimentally for absorption of H_2S in II using 3% soda ash and 8% NaOH. The latter medium completely removed H_2S from air with an inlet concn. of 45,200 p.p.m. Fatty Acid odors were removed using water as a scrubbing medium. The efficiency of an installed fume-disposal equipment in III was improved by reducing the steam concn. by means of water sprays. - Authors' Sum.

83. Kurtz, J.K.: Recovery and utilization of sulfur from coke oven gas. In Mallette, F.S. (editor): Problems and Control of Air Pollution. Reinhold Publishing Corporation, New York, 1955, pp. 215-221.

Without evaluating the benefits of a relatively unimportant reduction in air pollution, the utilization of a large proportion of the sulfur in coke oven gas in the manufacture of sulfuric acid is feasible and economically justifiable provided a substantial quantity of sulfur is recovered, and provided it is necessary to remove this sulfur to beneficiate the fuel and provided that it is necessary to have an assured source for sulfuric acid. - Author's Sum.

84. Larson, G.P., Fischer, G.I., and Hamming, W.J.: Evaluating sources of air pollution. Indust. Eng. Chem. 45:1070-1074, 1953.

Methods for determining the quantities of the various pollutants emitted within an area are presented and these emissions are discussed in relation to air sampling data. The tables presented include: (1) concentrations of pollutants in Los Angeles atmosphere during periods of good visibility and of intense smog; (2) losses of materials to atmosphere in relation to the quantities of material processed or consumed; (3) field test data on the emission of nonether-soluble particulates; (4) daily production and consumption of combustible material in Los Angeles County, 1951; (5&6) 1951 petroleum refinery and marketing hydrocarbon losses/day and (7&8) emissions to Los Angeles County atmosphere of aerosols, acid gases and aldehydes and of hydrocarbons by source for 1940, 1948 and 1951. Concentrations of pollutants in downtown Los Angeles, 1951 are calculated for periods of good visibility and of intense smog and compared with the measured values. Good agreement is found for N oxides and SO_2, while calculated values are much higher for total hydrocarbons and much lower for organic acids and lower aldehydes. This is interpreted as confirming the oxidation of hydrocarbons to aldehydes and acids, whereby the concentration of the former would be reduced and that of the latter increased. Aerosols are evaluated in terms of their ability to reduce visibility. This is determined by means of a relative pollution index (R.P.I.) for each material which is based upon the radius of the aerosol particle involved, its index of refraction and the quantity.

The build-up of pollution from 1940-1948, the technological changes contributing to this build-up and the reductions in pollution that occurred from 1948-1951 are discussed. Of particular importance were the increased release of unsaturated hydrocarbons to the air from expanded refining activity and greater gasoline consumption, and the use of catalytic cracking which forms more branched-chain paraffins than thermal cracking. These branched-chain paraffins form stable peroxides in sunlight which increase the rate of oxidation of olefins. The scope of future control measures is indicated. - KB

85. Larson, G.P.: Air pollution control in Los Angeles. Modern Sanit. 5:23-25, and 68, 1953.

The smog mixture in Los Angeles consists principally of dusts, smoke, condensed fumes, oil mists, peroxides, aldehydes, organic acids, SO_2, N oxides and certain hydrocarbons; these are grouped into aerosols, and gases and vapors. The aerosols, mainly the ether-soluble aerosols, H_2SO_4 mist and dusts, are listed in order of decreasing ability to reduce visibility. The individual components of the gas or vapor phase are also listed; they are predominantly hydrocarbons, easily undergo photochemical reactions in the air and are responsible for eye, nose and throat irritation and damage to vegetation. The results to date of the Los Angeles control program are summarized. The total daily emission of pollutants has been decreased by 600 tons. In particular, S is being recovered from 360 tons SO_2/day; this represents a 50% reduction in SO_2 emission. Dusts, fumes and other aerosol emissions from various industries have been reduced by 70 tons/day. Refinery losses of gasoline have been cut by 100 tons/day. The emission of 60 tons of smoke, 50 tons of organic acids and 10 tons of aldehydes from combustion processes has been eliminated. The number of days of dense smog has been decreased and visibility increased. Although the present control program is effective, new sources of pollution are arising faster than they can be handled and will require more research. The many fields which need further study, e.g., air pollution zoning program, micrometeorology, rubbish disposal, either by conservation or combustion, physiological effects of air pollution and control of gasoline vapor and auto exhausts, are discussed. A large number of other projects that are currently being studied are reduction of SO_2 from coal and oil burning equipment, improved fly ash collectors, basic studies on filter media, analytical methods and instrumentation. - KB

86. Laxton, J.W., and Jackson, P.J.: Automatic monitor for recording sulfur trioxide in flue gas. J. Inst. Fuel (London) 37:12-17 (Jan.) 1964.

A reliable and accurate automatic analyzer has been developed to determine concentrations of sulfur trioxide in flue gas down to about 0.5 ppm. v/v. The reaction between sulfate ions and the barium salt of chloranilic acid has been utilized in a simple colorimetric system to give continuous records for periods of several hours. The present instrument has a normal full-scale range of 0.5 to 50 ppm. (v/v), but this can easily be varied to between 0.2 and 10 ppm. and 1 to 100 ppm. sulfur trioxide, precision of about 2 % of the full-scale reading can be achieved over each working range. Readings are given every 45 sec., delayed for 3 or 4 min. by hold-up through the system. The instrument has been used in trials on power station boilers and on a small laboratory combustion unit, 2 gal./h^{-1} fuel oil; simultaneous check determinations made with manual apparatus and acid deposition probes have shown good agreement within the known limits of the techniques. - Authors' Abst.

87. Lessing, R.: The industrial aspects of disperse systems in air and gases. Introductory paper. Trans. Faraday Soc. 32:1218-1223, 1936.

Disperse systems in gases in their relation to the problems of industry and the amenities of life have not yet received the close study which their ubiquity and practical importance demand. The present survey is therefore not intended to be a record of work done, but to indicate the problems which still await solution and the directions in which the results of fundamental investigations can and should be applied in practice. The dispersoids to be considered comprise solids, liquids, solids covered with liquid films and liquid droplets containing solid nuclei.

Some of these systems happen to occur in many industrial operations, some form natural phenomena of climatic conditions, others are undesired concomitants of the atmosphere peculiar to civilized conditions of life and work, whilst yet others such as war gases and smoke screens, are set up intentionally as products of the latest developments of human activity. - Author's Abst.

88. Lessing, R.: Watch sulfur in the air, warns chemist. Municipal J. (London) 66:2545 (Oct. 3) 1958.

It has been pointed out that sulfur compounds in the air are more damaging to health and property than any other pollutant. Yet sulfur pollution of the atmosphere is not dealt with in Britain's Clean Air Act for two reasons: (1) lack of adequate knowledge of the causation or behavior of the pollutant sulfur compounds; and (2) slowness in developing generally applicable methods of dealing with them. The following suggestions are offered: (1) at least part of the sulfur contained in fuels should be eliminated before they are burned; (2) attempts should be made to discover the mechanism by which sulfur dioxide becomes oxidized to sulfur trioxide; (3) means should be found to neutralize this trioxide; (4) studies should be made to determine how sulfur dioxide reacts with solids of different chemical composition; acid, alkaline, or neutral, such as are found in flue dust mixture, to help in finding means to eliminate sulfur oxides from flue gases and to aid in the biochemical studies of the action of sulfur acids on the human and animal body; (5) an independent, impartial inquiry into the controversial subject of flue gas washing should be undertaken; and (6) surveys should be made on the distribution of sulfur dioxide in built-up areas. - APCA

89. Linsky, B.: Report to Detroit Common Council on emission of odor, smoke, gas, etc., from diesel-engined coaches. APCA News 3:1,4,5., 1955.

The smoke-emitting properties of diesel, gasoline and propane powered buses are compared. Smoke results only from improper engine maintenance, improper engine adjustment or improper fuel. However, these precautions are not always heeded. Smoking gasoline buses usually put out more visible smoke when decelerating; smoking diesel buses put out more smoke when accelerating. Both of these are avoidable. More odorous gases are emitted when smoke is being emitted; however, they are also emitted without visible smoke by Diesels when accelerating and by gasoline engines when decelerating even when the engines are in perfect adjustment using the most proper fuels. There has been some technical work done recently and currently on the measurement of odor in engine exhaust gases. Exhaust gases from buses are not significant in area-wide pollution, particularly since buses are a small % of the motor vehicles. Localized effects in and near the bus, before any great dilution takes place, are the following: an odor from CHOH and other aldehydes; no odor from CO and CO_2; mild odor from exhausts from hydrocarbons and from oxides of N and SO_2. The diesel engine emits ca. 1/100 as much CO as the gasoline engine, emits no Pb compounds, 40% more N oxides, 40% more CHOH except when decelerating and 60% less hydrocarbons especially when decelerating. No detrimental effect on vegetation was found during studies of this phase for the past 2 yrs. Propane-fueled buses produce no Pb compounds, and are reported to stand between gasoline and diesel buses with respect to the emission of CO, oxides of N and hydrocarbons. - KB

90. Loeser, C.: The role of sulfur dioxide in damages through flue gases. Chem. -Ztg. 66:337-340, 1942.

The author presents the legal aspects of the problem of damages caused by waste gases, especially when SO_2 is one of the constituents. The reasons for and the applications of some German laws pertaining to compensation of these damages are explained. In the discussion of the toxic effects of SO_2 on vegetation, animals and on man, the following concentrations are pointed out: A SO_2 concentration of 1:500,000 is harmful to roses, which are known to be highly sensitive to the action of the gas. A SO_2 concentration of 12-15 ppm in the air is slightly irritating for man, 400 ppm produce dyspnea, while 500 ppm prevent breathing in adult humans and may lead to their deaths. Children are much less resistant to the effects of the inhalation of SO_2. The following symptoms are considered typical for the toxic effects of SO_2 in man: irritation of the respiratory tract, convulsive cough, cyanosis of the mucosae, bronchial catarrh, conjunctivitis and frequently also pneumonia as well as dyspepsia.

In the discussion of the amounts of SO_2 given off by burning different types of coal, the author assumes an average content of 1% of combustible S in the coal. Depending on the type of coal burned, the waste gases given off through the chimney may have a SO_2 concentration of 200-4000 ppm by volume. Various attempts and methods to render the gas harmless are described, such as endeavors to induce increased dilution of SO_2 in the air or to construct various devices within the chimney. The great influence of the wind velocity on the toxicity of the waste gases is stressed. In conclusion, the author describes a cone-shaped hood which he had designed and which seems to contribute to the solution of the problem of detoxication of waste gases. The hood is built into the chimney and provides great additional amounts of air which join the waste gases before these leave the chimney. Thus, they are diluted before being given off and also escape with greater velocity, which, in turn, causes increased dilution of the gases in the atmosphere. - KB

91. Lucas, D.H.: The atmospheric pollution of cities. Internat. J. Air Poll. 1:71-86 (Oct.) 1958.

The paper assesses the pollution levels of sulfur dioxide (and smoke) likely to be produced by the thousands of domestic fires in large cities. It shows that the major part of the pollution measured in large cities can be attributed to domestic fires even though the concentrations produced by a single fire are negligible. An approximate formula is given so that city concentrations can be estimated if the rate of emission, the wind speed, and the size of the city are specified. The worst pollution occurs about a mile downwind of the center of the city and pollution levels decrease extremely rapidly outside the city boundary, particularly when averaged over a range of wind directions. When the atmosphere is stable, ground-level concentrations tend to be high. The effect of fog is complex and uncertain. It appears likely, however, that SO_2 (and smoke) is removed by the fog and that the "time constant" is between 8 and 20 hr. - Author's Abst.

92. MacKenzie, V.G.: The Power Industry and Air Pollution. USDHEW, PHS, Division of Air Pollution, Washington, D.C. 20201. 1962. 11 pp.

The principal air pollutants of concern from thermal power generating stations are smoke, fly ash, and other particulates including polycyclic hydrocarbons, and the gaseous oxides of nitrogen and of sulfur. The power industry has available a wide variety of procedures relating to air pollution control. For the control of smoke and other particulates, available technology as related to furnace design combined with the use of mechanical collectors and electrostatic precipitators would appear to provide reasonably adequate methodology. The situation with respect to the principal gaseous pollutants of interest, the oxides of nitrogen and of sulfur, is not as satisfactory. Industry's responsibility must include a sharing with the government in the research and development of better control techniques especially in those areas where available methods are inadequate or too expensive to be deemed feasible. Such an area for which adequate control techniques are not on hand is that of the sulfur oxides. The Federal Government is conducting and sponsoring research designed to increase the ability to control sulfur oxides, but its efforts alone are not enough. Those industries which contribute significant amounts of sulfur oxides to the atmosphere, such as the power industry, must also increase their efforts toward developing feasible methods of control. We all agree that the quality of our air resource must be conserved or recovered in our common interest. It is now time to agree that the problems involved are also our common problem. - APCA

93. Magill, P.L., and Benoliel, R.W.: Air pollution in Los Angeles County. Contribution of combustion products. Indust. Eng. Chem. 44:1347-1351, 1952.

"Combustion products from approximately 50,000 tons/day of fuel and rubbish are emitted to the atmosphere in Los Angeles County. Public and industrial burning of these materials emits to the area each day at least 1800 tons of impurities, not including CO." Approximately 70% of this amount is organic in nature, 15% - N oxides and 15% - SO_2. Household burning of 4000 tons of trash, the biggest single source, sends 550 tons of organic materials/day into the air. Exhaust fumes from approximately 2,000,000 automobiles, busses and trucks in the county contribute another 350 tons of organic substances, 30 tons of aldehydes and 40 tons of N oxides. Detailed data are presented showing the sources of the various impurities and the quantity each source emits. - KB

94. Marsden, D., and Mott, R.A.: Oxides of sulfur in the flue gases of a coke-fired domestic boiler. J. Inst. Fuel 33:267-270 (June) 1960.

The Corbett-Flint method for the determination of sulfur trioxide in flue gases, as modified by Mott and Parramore, was applied to a study of the effects of various factors on the concentration in the flue gases of a coke-fired domestic boiler. The sulfur content of the coke had no effect. Increase in the rate of combustion caused a slight increase. The range of concentration was 7.4 ± 1.8 p.p.m. which is much less than that in the flue gases of power-station boilers. Most of the sulfur of the coke was released as sulfur dioxide, the concentration of which was roughly proportional to the sulfur content of the coke. Ammonia was present in the flue gases concentrations of about 30 ± 5 p.p.m. - PHEA

95. Marsh, A.: A review of the domestic smoke problem. Smokeless Air J. Nat. Soc. Clean Air No. 122, Summer 1962, pp. 272-278.

The domestic chimney is now the most serious single source of air pollution in Great Britain, and its harmful consequences are now known to be greater than had previously been realized. The problem is being solved, but at a slower pace than is possible and desirable, and the necessary action is lagging behind the practical progress that could be made. Solid smokeless fuel supplies are satisfactory but future progress can best be ensured by encouraging a greater diversity of use of gas, electricity and oil. The criticisms and difficulties that have been encountered in developing the smoke control area programme are small in comparison with the success that this has attained as shown by its effectiveness in what is now approaching a million homes. But a great deal more education on the importance of clean air is needed among both the general public and a not inconsiderable number of local authorities.

To the latter one cannot do better than repeat the admonition that ends the Minister's Circular of January 30, which asks local authorities in the black areas who have not yet prepared programmes "to consider again most carefully whether their present policy is consistent with the health and well-being of their communities." - Author's Concl.

96. Marsh, A.: The removal of sulfur pollution. A survey of the problem - for discussion. Smokeless Air J. Nat. Soc. Clean Air No. 125, Spring 1963, pp. 302-304.

This review, though far from complete, may suffice to show that sulfur removal is far from being a one-solution problem and that progress may be made in a number of different ways. These include the greater use of sulfur-free fuels or sources of power, sulfur-reduced coal and smokeless fuel, removal of sulfur oxides from flue gases where applicable, very tall chimneys where applicable, higher efficiency in the domestic use of solid fuel, avoidance of too high a density of fuel use in certain areas, and control of fuel if specified MAC limits are approached.

There seems ample scope for discussion, inquiry and the formulation of a definite policy on the problems involved - a policy which would indicate the lines on which further research and development are needed. - Author's Concl.

97. Matty, R.E., and Diehl, E.K.: Measuring flue-gas SO_2 and SO_3. Power 101:94-97 (Nov.) 1957.

This paper describes a method of improved sampling and analysis of boiler flue gas for SO_2 and SO_3. The results can be produced quickly and accurately under the adverse analytical conditions of a field testing program. Results can be obtained within one hour after sample collection. Therefore, a number of samples per day may be analyzed-results of any test being known before starting the next one. Unstable standard solutions have been eliminated. The one standard solution used, N/10 H_2SO_4 can be kept indefinitely without important change in strength.

Need for laboratory facilities has been eliminated. The test needs only a small table, standard laboratory glassware and distilled water. Considering normal slight sampling and analytical tolerances, which may affect calculated and measured values, test results with this apparatus check the calculated fuel analysis and combustion data very well.

SO_3 absorption system collects efficiently all the SO_3 that enters the sampling equipment and holds oxidation of SO_2 in the sampling train to a minimum. This insures accurate measuring of SO_3 in the flue gas at any location in the boiler. - Authors' Sum.

98. McCabe, L.C.: Atmospheric pollution. Indust. Eng. Chem. 43:83A (Aug.) 1951.

The author discusses several important papers on sulfur recovery from flue gases that were scheduled for presentation at the International Congress of Pure and Applied Chemistry in Sept. 1951. Katz in his presentation discusses the sulfur shortage which is causing more than one large consumer of coal to look into the possibility of recovering sulfur from stack gases. He estimates that more than 25,000,000 metric tons of sulfur gas goes into the air each year from coal burning installations.

S.R. Craxford describes in his paper the operation of an ammonia process. S.H. Richards concludes his presentation with stating that the main obstacles of removing oxides of sulfur from flue gases by the process in use in Battersea are the very high capital and operating costs. Finally, Bruins and his associates who have investigated atmospheric pollution by fluorine compounds in Rotterdam and its environs, are concerned with the nature and control of contaminants released to the air from three superphosphate plants and an enamel frit factory.

99. McPhee, D.T.: Power plant using high sulfur coal takes steps to reduce air pollution. Indust. Water & Wastes. 8:9-11 (Jan.-Feb.) 1963.

The Montrose steam electric station of the Kansas City Power and Light Co. is located in the remote rural section of a high sulfur coal deposit, accessible by strip mining. Dust collectors and a 250 ft. chimney eliminated much of the problem of fly ash removal and SO_2 dispersion, and the company is making an effort to alleviate local pollution. This is to be accomplished by a complete conversion of the station to 450-ft. stacks and 2-300 ton, 95% electrostatic precipitators. - APCA

100. Meetham, A.R.: Atmospheric Pollution--Its Origin and Prevention. London, Pergamon Press, Ltd., 1952, 268 pp.

The following topics are discussed in this book: origin of fuel, natural fuels, artificial fuels, industrial boilers, power and electricity, industrial furnaces, domestic fires, atmospheric pollution, measurements of atmospheric pollution, distribution of pollution, changes in pollution, effects of pollution, prevention of atmospheric pollution and the law and its administration.

In the chapter on atmospheric pollution, the approximate constitution of the atmosphere at 10 C. and normal pressure is given under the divisions of major and minor constituents and impurities. The maximum allowable concentrations, in mg./m.^{3}, for prolonged exposure, and concentrations in town and in country on both hazy winter days and in summer are given, though incompletely, for the impurities, viz., SO_2, combustible solid and liquid particles, incombustible solids, CO, SO_3, NH_3, HCl, H_2F_2 and H_2S. Very generally, concentrations on a hazy winter day are ca. 5 times those in summer and the maximum allowable concentrations are 10-20 times those on a hazy winter day. The individual pollutants of smoke, ash, SO_2, other pollutants from the combustion of fuels, gases from chemical works and from offensive trades and particles are discussed.

The distribution of the various impurities throughout England is discussed. Insoluble solids were found to vary greatly with the density of industry, the pollution being 2-3 times heavier at the center of industry than in the rest of town, and town pollution being ca. 10 times heavier than in the country. Soluble solids, however, were only ca. twice as concentrated in town as in rural areas. These latter are more easily carried by the wind, and some of them may even come from evaporation of the sea. Changes in both deposited and suspended air pollutants are effected by human activity and the weather. The various aspects of these 2 factors, e.g., the yearly, weekly and daily cycles, wind direction, rainfall, temperature, wind speed and turbulence, are discussed.

The effects of air pollution on human health, animals, plants and material things are generally discussed. - KB

101. Middleton, J.B., and Tigges, A.J.: Control of air contaminants from a valley power station - action of specific airborne contaminants. Proc. Amer. Power Conf. 24:491-499 1962.

The behavior of particulates and sulfurous gases in the atmosphere and their effects on living conditions, materials, and vegetation are discussed. The two basic conditions under which sulfurous flue gases and associated solids cause annoyance are the cool days of stagnation where there is deep fog, and windy days as the flue gases are carried to ground level. While field studies and analyses of the airborne contaminants were made in the Seward area, the two major nuisances were SO_3 and airborne solids; others were unburned hydrocarbons and SO_2 gas. Removal of the fine particulates and suspended matter from the flue gases generated by pulverized coal-fired boilers reduced the area deposition, SO_3, and H_2SO_4 mist. Precipitation removes the solids and SO_3 when the flue gas temperature is maintained below 285°F. Nine areas were inspected and showed that the levels of concentration of SO_2 had not been high enough to cause serious damage to vegetation. The availability of weeds, vines, vegetables, and other plants sensitive to SO_2 were useful in locating and evaluating the presence and intensity of accumulated fumigations.

102. Miura, T., Kimura, K., Akutsu, A., Tada, O., and Sato, T.: On the contribution of engine exhaust to air pollution. J. Sc. Labour (Tokyo) 37:577-582 (Nov.) 1961.

For the purpose of investigating the contribution of engine exhausts to air pollution, determinations of air pollutants were carried out at Shinjuku, 1 of the heavy traffic junctions in the city of Tokyo, during the 1st week of March 1960. As indicators of degree of air pollution from engine exhausts, the concentration of CO, SO_2, NO_2, HCHO, and dust concentration in atmospheric air were employed. Traffic density was obtained by counting, using a manual counter, all of the cars and trucks passing the intersection for 10 min. in each hr. The concentration of CO was in the range of 3-10 ppm.; SO_2, 0.8-4.9 pphm.; formaldehyde, 0.7-1.7 pphm.; and nitrogen oxide, 0.7-4.1 pphm. Eye irritation was not experienced at these concentrations. The correlation between the concentration of air pollutants and the traffic density was not significantly high. - APCA

103. Miura, Y.: Chemical studies on the sulfur of Japanese coals. I. Introduction and distribution of sulfur compounds in coal. J. Fuel Soc. Japan (Tokyo) 41:209-223 (March) 1962.

The solution of fundamental problems on the sulfur content of coal is very important from the viewpoint of coal utilization. In this study, the results of research on desulfurization and the type of chemical compounds of sulfur in Japanese coal (mainly, bituminous coal for metallurgical use) are reported. A summarization of the literature survey for the forms and carbonization properties of sulfur compounds in coal is described in this 1st paper. Also, the method for estimation and distribution of sulfur compounds contained in Japanese coal is investigated, comparing it with foreign coals. When the reduction method of Radmacher et al. - hitherto customarily used for foreign coals - was applied to the estimation of pyritic sulfur in Japanese coal, instead of the oxidation method of Powell, the time required was considerably reduced. It was found that the amount of organic sulfur found in the sample was increased as the total sulfur was increased, the organic sulfur amounting to 80% of the total. There was a definite relationship between organic sulfur content and coal quality. The levels at which the maxima of the mean curves showing the distribution of organic sulfur contents were obtained, were 84% and 86% for carbon (for Japanese and foreign coals respectively), 5% and 4% for hydrogen, and about 40% and 20-30% for volatile matter. Kereulen's opinion concerning the origin of coal sulfur (that oxygen is displaced by sulfur during coalification in the case of high-sulfur coal), was found to be applicable to the low-sulfur coal. - APCA

104. Mokhov, L.A., and Matseeva, S.A.: Quantitative colorimetric determination of hydrogen sulfide in air. Lab. Delo 8:4-7 (March) 1962.

Air (25 liters) was passed through 8 ml of water-ethanol (10:1) at 2.5 ml per min. Then to the water-ethanol mixture was added 2 ml of reagent soln. (0.95 g of $NaHCO_3$, 1.35 g of Na_2CO_3 and 0.5 g of sodium nitroprusside in 500 ml). After 15 to 20 min. the extinction was measured or the color was compared with those of a series of Na_2S son. standardized iodimetrically. The colors of standard soln. of low concn. are stable for 5 hr.; those of conc. standards are stable for 7 hr. The sensitivity is 0.005 mg per ml. Ammonia, CO_2, aliphatic amines, acetone, formaldehyde, acraldehyde, benzene, alcohols, and indole do not interfere.

105. Monkhouse, A.C., and Newall, H.E.: Industrial gases - recovery of sulfur dioxide. Paper to Soc. Chem. Ind. Conf. Sheffield, 1956. Brit. Chem. Eng. 1:99-100 (June) 1956.

The authors discussed the removal of flue gases under several headings. These include: scrubbing with water; scrubbing with organic base; scrubbing with an aqueous solution of an in-organic base (e.g. lime, ammonia, magnesia) or with the sulfite of the base; oxidation of the sulfur dioxide to sulfur trioxide by an electrical discharge; and the fixation of the oxides of sulfur as a dry, solid compound. A diagram is given of the pilot plant of the Fulham-Simon-Carves process at the Fuel Research Station, in which sulfur dioxide is removed from flue gases by scrubbing with gas works liquor. A large pilot plant to treat 2 million ft.^{3}/hr. of flue gas is being installed at Nottingham power station. - APCA

106. Mott, R.A., and Parramore, K.: Determination of sulfur trioxide in flue gases. J. Inst. Fuel 30:123-126 (March) 1957.

Corbett-Flint method for determination of sulfur trioxide in flue gases studied in connection with problem of small coke fired appliances; modified method is being applied in investigation of effect of various factors on production of sulfur trioxide in coke fired domestic boiler; preliminary results suggest increase in concentration of sulfur trioxide with increase in rate of combustion. - PHEA

107. Nelson, H.W., and Lyons, C.J.: Sources and control of sulfur-bearing pollutants. J. APCA 7:187-193 (Nov.) 1957.

The 3 principal sulfur-containing pollutants are sulfur dioxide, sulfur trioxide, and hydrogen sulfide. Hydrogen sulfide is listed here as a primary pollutant, although it usually is burned to form sulfur dioxide and water vapor before being vented to the atmosphere. The greatest proportion of the sulfur compounds emitted to the atmosphere is in the form of sulfur dioxide. This form is produced from the smelting of ores of metals such as zinc, lead, copper, and nickel, from the combustion of gases from refinery and natural gas waste products, and from the combustion of oil and coal. Methods of control are outlined, removal of sulfur-containing pollutants, catalytic conversion process, and other processes are discussed. - APCA

108. Newall, H.E.: Ammonia process for removal of sulfur dioxide and flue gas. In Mallette, F.S. (editor): Problems and Control of Air Pollution. Reinhold Publishing Corporation, New York, 1955, pp. 170-190.

The use of an aqueous solution of ammonia to absorb sulfur dioxide from flue gas was suggested as long ago as 1883. In the past twenty-five years, other patents relating to the recovery of sulfur dioxide by ammoniacal solutions have been granted and processes using ammonia have been developed to pilot-plant and full scale. This paper deals with experiments carried out to study a two-stage scrubbing process, using a dilute solution of ammonium salts in the second stage. Efficiencies of removal of oxides of sulfur of 95 percent, with a loss of ammonia in the washed gas of 3 to 8 percent of the ammonia added to the scrubber, were obtained with two-stage scrubbing.

109. Padovani, C., Berti, V., Sartirana, D., and Bosoni, B.: Catalytic refining and hydro-desulfurization of mineral oils. Proceedings Fifth World Petrol. Congress, Section III. World Petroleum Congress, Inc., New York, N.Y., 1959, pp. 83-102.

Laboratory experiments in catalytic refining are described, performed on the following products:

1. petroleum topping distillates: gasoline and gasoils
2. topping long cuts
3. catalytic cracking gasolines and light coal tar oils
4. catalytic cracking kerosene and gasoils
5. deasphalted crudes

These experiments were carried out at medium pressure in the presence of hydrogen on cobalt-molybdate catalysts on a natural alumina support. The conditions adopted for the experiments and the characteristics of the refined products are reported in detail.

Catalytic refining was also extended to Middle East crudes, processed beforehand to segregate part of the asphalts and mineral substances.

The results achieved in refining long cuts and deasphalted crudes give an idea of how the catalytic process may be successfully employed also with wide cut fractions and on whole crudes and how highly refined fractions can be obtained from the subsequent fractionation of the latter. - Authors' Abst. of Part I

This part of the report gives the description and the operating data of a catalytic refining plant built by the Societa Petrolifera Italiana at Fornova Taro (Parma, Italy). The catalytic unit has a fixed-bed catalyst composed of cobalt-molybdate on a natural alumina support.

This plant can run optionally to reform gasolines or for the desulfurization-refining of light and medium petroleum distillates. Reforming charges may consist of long cut or of light gasolines, while charges for desulfurization-refining should be gasolines and gasoline-kerosene blends. The industrial run has proved the advantage of operating for reforming with a fresh (or regenerated) catalyst and of operating for desulfurization with the partially spent catalyst.

Catalyst activity, despite the continual changes in load and operating conditions, was still good after two years and the catalyst proved to have good regenerability. One catalyst charge has so far processed 11,000 volumes of liquid per catalyst volume (including 3,000 for reforming) and has been regenerated six times. - Authors' Abst. of Part II

110. Parker, A.: Air pollution in Great Britain from the treatment and use of fuels. Paper 9 M/1 to Sec. M, 5th World Power Conf. Vienna,1956, 23 pp.

The quantity of coal used within Great Britain in 1954 was 210 million tons, and the quantity of petroleum oils used as fuels was 19 million tons (equivalent in thermal value to about 30 million tons of coal). It has been estimated that the quantities of the main air pollutants discharged from the treatment and use of these fuels were 2 million tons of smoke, nearly 1 million tons of grit and dust, more than 5 million tons of sulfur dioxide, and between 20 and 30 million tons of carbon monoxide. Systematic measurements of the extent of pollution in various parts of the country were begun more than 40 yrs. ago. There are now more than 1700 instruments in regular use for making these measurements. In some of the thickly populated industrial areas, the amount of deposited solid matter is equivalent to between 500 and 2000 tons/sq. mile/yr. in comparison with the equivalent of between 10 and 100 tons in rural areas and small country towns. More than ½ of this pollution by grit and dust is from the treatment and use of fuels. Air pollution by smoke ranges from less than 1 mg./100m^3 in country districts in summer to more than 100 mg./100M^3 in thickly populated industrial towns in winter. In the air of towns, at or near ground level, the concentrations of sulfur dioxide in winter is usually in the range 5 to 100 mg./100M^3 (2 to 40 parts/million by vol.). The concentration of carbon monoxide is usually well below 1 ppm. by vol., but in areas of dense motor traffic it often reaches 50 ppm. under normal meteorological conditions. At times of dense fog, the concentrations of smoke, sulfur dioxide, and carbon monoxide in the air of towns can rise to several times their normal values for the same time of yr. The cost of damage by air pollution in Great Britain has been estimated to be equivalent to at least 250 million a yr.; and this estimate does not include much of the damage to health. On the basis of existing knowledge, there could be obtained within a reasonable time a considerable reduction in pollution of the air by smoke and grit and dust, and there could be some reduction in pollution by carbon monoxide. - APCA

111. Pearson, J.L., Nonhebel, G., and Ulander, P.H.N.: The removal of smoke and acid constituents from flue gases by a non-effluent water process. J. Inst. Elect. Eng. 77:1-33 (July) 1935.

Progress in the electricity supply industry has led to a large increase in the coal consumption of individual power stations and is leading to the erection of power stations consuming over 1,000 tons of coal per day.

This concentration of coal consumption in a small area has greatly intensified certain aspects of atmospheric pollution, owing to the creation of "point" sources of very substantial emission, i.e. sources of an order of emission unknown some 25 to 30 years ago. The almost immediate effect of the developments in power station "size" has been to bring the 600-year-old question of atmospheric pollution to a stage insistent upon practical solution for the consumption of 1,000 tons of average coal leads to the formation and emission of 45 tons of sulfuric acid, 3 to 7 tons of nitric acid and half a ton of hydrochloric acid, as well as to substantial amounts of dust.

Three new power stations, Battersea, Swansea, and Fulham, indicate clearly the trend of flue-gas cleaning requirements in urban areas. In the past, manufacturers of flue-gas cleaning apparatus have devoted their activities, mainly to the removal of grit, partly to the removal of dust, and not at all to the removal of the acid constituents in the gas emission. This is well illustrated in Table 1, where under the second column of "Percentage removal" it will be seen that the performance of standard flue-gas cleaning apparatus in removing the acid constituents is negligible, except for the developments in new apparatus referred to at the end of the table.

It should be noted that the figures represent stated performances of plants and that the methods of testing were probably different in most cases and of unknown accuracy-except for the two cases at the end of the table. The table is mostly compiled from information given in the 1932 Report of the Committee appointed by the Electricity Commissioners and in a report of the Prime Movers Committee of the U.S.A. - Authors' Sum.

112. Pekarek, V.: Pollution of the atmosphere in the soft-coal basin of Most-Usti. Prac. lek. 4:339-345, 1952.

A preliminary study was carried out in the soft-coal basin of Most-Usti to ascertain the pollution of the atmosphere with both smoke and exhaust gases from plants. Attention was directed to finding macroscopic changes in the plants, especially in the forest vegetation. The SO_2 content of 253 air samples was determined. Simultaneously, wind directions and velocities as well as the air temperatures were recorded. In 5 areas in the soft-coal basin of Most-Usti, injurious effects of economic significance were found in plants which were especially pronounced with regard to forest growth. In some air samples collected during fog at a distance of several hundred meters from the source of contamination, the amount of SO_2 exceeded 25/1. The investigation is being continued on the basis of the findings reported here. - KB

113. Peterson, G.R., and Grossley, H.E.: Atmospheric Pollution Arising from Power Station Operation. Union of the Internat. Energy & Electricity Congress, Paper No. 14, Sept. 1955, 16 pp.

The paper describes the contribution which the electricity supply industry is making to the reduction of atmospheric pollution by the control of emissions from thermal-electric generating stations. The first part deals with solid pollution (grit or dust) and describes the precautions ehich can be taken in the design and operation of power stations to prevent the dispersion of such solids in objectionable concentrations from chimney gases. The second part deals with the control of gaseous pollution from power station chimneys and refers especially to sulfur dioxide pollution. Results are given of the measurement of the dust fall and sulfur dioxide concentration in the air in the neighborhood of large power stations. No serious pollution arises from the correct operation of a well designed station.

114. Purcell, P.R., and Williams, T.H.: The Extraction of Sulfur from Coke-Oven Gas and the Manufacture of Sulfuric Acid. Proc. Air Pollution Meeting -- Iron and Steel Inst. London (Sept. 25-26) 1957. Special Rept. No. 61, 1958. 56-61.

This paper describes the plant installed at the Corby coke-ovens for the desulfurization of coke-oven gas by the Collin ammonia process and the production of sulfuric acid from the recovered hydrogen sulfide by the Chemiebau wet contact sulfuric acid process. Operation of the plant is discussed and modifications which have been incorporated are described, and recent developments of the process are reviewed. - APCA

115. Radmacher, W., and Hadicke, K.: Determination of sulfur dioxide and sulfur trioxide in flue gases. Staub 18:174-176 (June) 1958.

This paper deals with the method to determine sulfur dioxide and sulfur trioxide separately, as proposed by P.F. Corbett. It was found that the gravimetric determination of sulfur trioxide as barium sulfate is expedient, rather than the nephelometric barium sulfate determination. In order to attain a quantitative precipitation it is necessary, after the test is finished, to furnish the absorbent solution with an exactly determined quantity of 0.1 N sulfuric acid.

116. Reed, H., Reaugh, M.A., and Stribley, A.F., Jr.: The petroleum industry and smog. Petroleum Processing 4:391-394, 1949.

Petroleum refiners in the Los Angeles area, even though their plants are not believed contributing to the eye-irritating smog there, have taken a principal part in the smog relief program, through their Smoke and Fumes Committee of the Western Oil and Gas Association. Research departments of the individual oil companies initiated studies to determine the nature and extent of contaminants in the air. The research program was later expanded and transferred to Stanford Research Institute.

In addition the refiners took direct steps to minimize air contamination from sulfur dioxide resulting from refinery operations. The burning of sludge sulfuric acid was voluntarily discontinued. A program costing several millions to remove sulfur from cracker fuel gas before it is burned is expected to be in operation in 1949. - Authors' Abst.

117. Reed, R.M., and Updegraft, N.C.: Removal of hydrogen sulfide from industrial gases. Indust. Eng. Chem. 42:2269-2277, 1950.

Removal of hydrogen sulfide from natural and manufactured gases has become of great importance in recent years because of more rigid specifications for pipe-line distribution, higher sulfur content in raw materials, and the depletion rate of mineral sulfur deposits. This paper reviews the various commercial processes used for this purpose. The only dry process in extensive use is the iron oxide process, largely used by utility companies for purification of city gas. The wet processes fall in the following classifications: nonregenerative processes, including caustic soda, lime slurry, potassium permanganate, and bichromate zinc sulfate; regenerative nonrecovery processes (the only process in commercial use in this classification is the Seaboard process); regeneration processes with recovery as hydrogen sulfide, including vacuum carbonate, Girbotol, phosphate, Alkazid, and phenolate; and regenerative processes with recovery as sulfur (the principal process used here is the Thylox process; the earlier Ferrox and nickel processes are now becoming obsolete). Various processes are selective in varying degrees for the removal of hydrogen sulfide in the presence of carbon dioxide. Potassium permanganate and bichromate zinc sulfate processes may be used for the removal of small quantities of hydrogen sulfide. Manufactured gas may be purified by the use of iron oxide, Seaboard, vacuum carbonate, and Thylox processes, which are highly selective. Natural and refinery gases may be treated with the Girbotol process using the tertiary amine, the phosphate process, or the Alkazid Dik solution for semiselective removal of hydrogen sulfide. - Authors' Abst.

118. Rees, R.L.: The removal of oxides of sulfur from flue gases. J. Inst. Fuel 25:350-357 (March) 1953.

The historical development of flue-gas washing at power stations is traced. Modern knowledge has yielded no evidence that ordinary flue gas discharged hot and at reasonably high speed from well designed chimneys is harmful to health or to agriculture; on the other hand, washing the flue gas opposes the good effect of a tall chimney by cooling the gas, so that washing may actually increase local pollution in certain states of weather. It is calculated that existing gas-washing processes (which are described briefly) cost the community more than the damage done by the sulfur dioxide that they remove. These processes are wasteful in that no useful material is recovered. The recovery of sulfur or its compounds and also the manufacture of ammonium sulfate from flue gas by the use of gas liquor are being investigated. - Cond. Author's Sum.

119. Rees, R.L.: Removal of sulfur dioxide from power-plant stack gases. In Mallette, F.S. (editor): Problems and Control of Air Pollution. Reinhold Publishing Corporation, New York, 1955, pp. 143-154.

The principal difficulty in the way of devising a satisfactory flue gas washing process for a modern power station lies in the severe requirement that at least 90% of the sulfur dioxide must be removed from gases flowing at a rate of more than 1,000,000 CFM. when the original concentration of sulfur dioxide is of the order of 0.1% or less. From the point of view of the authorities in Great Britain, there are only 3 possibilities at the present time: (1) the Battersea process, severely restricted in application by site requirements; (2) the cyclic lime process, extremely costly and presenting a huge waste-disposal problem; and (3) the ammoniacal liquor process which is restricted in its application by the supply of ammoniacal liquor, and which has only just passed from the stage of the laboratory to that of the pilot plant. Only the last is productive in the sense that any value is derived from the sulfur dioxide in the flue gases. The Battersea process is the only gas washing process in use at any power station in the world. The designers took advantage of the estuarine site and devised the simplest possible process. The River Thames supplies the water (which contains most of the alkali that is required to neutralize the sulfur dioxide) and it carries away the product, calcium sulfate in solution. The gas is washed on grid scrubbers with water to which a small amount of chalk has been added in order to maintain the alkalinity in the later stages of the washing process. Principal defects of the process are the high cost of maintenance, the extent to which it cools the gas, and the severe limitations on the sites at which it can be used. The paper discusses research in progress and briefly considers the effect of flue gas washing on air pollution. - APCA

120. Rees, R.L.: Present performance and scope for improvement in power station flue-gas washing equipment for the removal of sulfur dioxide. Smokeless Air J. Nat. Soc. Clean Air pp. 177-178, 1957.

A review of the methods of removing sulfur dioxide from power station flue gases: The Battersea effluent process which is in use at Battersea and Bankside Power Stations is removing up to 95% of the sulfur dioxide; the Fulham-Simon-Carves process for making ammonium sulfate and sulfur by direct reaction of gas-works ammonia liquor with flue gases, now undergoing pilot plant trials at Nottingham power station; and other ammonia processes that were developed at Trail Smelter are being considered for use in the U.S. by TVA. The removal of pyrites from coal is not generally feasible in Britain because of the very small size of the pyrites aggregates. The dry removal of sulfur dioxide from flue gases, which would not entail the cooling of the gas (a most serious defect of all flue-gas-washing processes because it causes the discharged gas to sink rather than rise) is being studied by the Central Electricity Authority. - APCA

121. Reeve, L.: Desulfurization of coke-oven gas at Appleby-Frodingham. J. Inst. Fuel (London) 31:319-324 (July) 1958.

An account is given of the chemical investigations leading to the development of a process for the desulfurization of coke-oven gas, using a fluidized bed of hot iron oxide at a temperature of approx. 350°C. A large pilot plant capable of dealing with the max. gas requirements of one of the large Appleby steel furnaces, amounting to about 2 ½ million ft.^{3}/day, has been installed. Desulfurization originally averaged 70% but has since been increased to a max. of 98% by inserting a second shallow bed in the absorption vessel. The process also removes organic sulfur from the gas to a degree comparable with the H_2S removal. Plans are in hand for the installation of a fullscale plant based on the same principle for the desulfurization of 32 million ft.^{3} of coke-oven gas/day, together with a dry contact plant for the manufacture of sulfuric acid from the regenerator gases. - APCA

122. Reidel, J.C.: Air pollution control in Houston area. Oil & Gas J. 54:107-109 (Sept. 5) 1955.

With increased pressure for atmospheric pollution control in population centers, refiners handling sour crudes have been installing sulfur-recovery units as an important aid to such control. Release of H_2S as such to the atmosphere is not permitted in populated areas. A small quantity of H_2S might be burned in a flare stack or boiler and released to the atmosphere as SO_2, but a large refinery produces too much H_2S to dispose of in this manner. Accordingly, the Sinclair Refining Co. at Houston, Texas decided to install a sulfur-recovery plant with capacity of 30 ton/day of commercial sulfur. This is part of a $3,500,000 atmospheric-pollution-control program at the refinery. In the new unit, hydrogen sulfide from strippers is converted to sulfur by controlled combustion with air (burning one-third of the hydrogen sulfide to sulfur dioxide) and subsequent reaction between the sulfur dioxide and remaining hydrogen sulfide to form sulfur. The new unit incorporates latest design features, including: (1) amine stripper is located at the sulfur-recovery unit; (2) to aid in smooth operation of the sulfur plant the operator can control the amount of rich amine feeding the amine stripper; (3) provision is made for release of hydrocarbon vapors from the amine stripper back to the refinery flare; (4) this is the first sulfur-recovery unit in which the reactors and scrubber sections are combined in one column with internal dished heads separating the sections; (5) latest instrumentation features for this type of plant have been incorporated to facilitate operation. As a result the plant can be operated by one man. - APCA

123. Restricting Emission of Sulfur Dioxide from Coke Ovens and Gas Plants. VDI Specifications 2110. Aug. 1960, USDHEW, PHS, Div. of Air Pollution, Washington, D.C., 1963, 14 pp.

These VDI Specifications for restricting the emissions of sulfur dioxide from coke ovens and gas plants, are outlined under the subject heading of: Technology. Reduction of emission and low-layer concentration of sulfur dioxide. Guide lines for the restriction of sulfur dioxide emission.

Restricting Emission of Dust from Manually-Operated Central-Heating Boilers, Capacity 600,000 Cal./Hr. and Less, Fired with Solid Fuels. VDI Specifications 2115.

The VDI Specifications for restricting emissions of dust from manually operated central-heating boilers, under specified conditions, are outlined under the subject headings of: Technology. Reduction of dust and soot emission. Reduction of dust emission.

Restricting the Emission of Fumes from Diesel-Engines. VDI Specifications 2281.

These VDI Specifications for restricting the emission of fumes from diesel-engines are outlined under the subject headings of: Composition of diesel exhaust fumes; Causes of black diesel exhaust; Measurement of diesel exhaust fumes; Measures for maintaining permissible tolerance; and Evaluation of fume density and permissible tolerance. - APCA

124. Salem, H., and Cullumbine, H.: Kerosene smoke and atmospheric pollutants. Arch. Environ. Health 2:641-647 (June) 1961.

In the air pollution disasters that occurred in London in 1952, Donora in 1948, and the Meuse Valley in 1930, there were more than 4,000 deaths in one week over and above the normally recorded expectation. The elevation in the death rate was considered due to the effect of toxic substances in the atmosphere. Some of these substances have been identified, while others have escaped specific detection. The concentrations of these pollutants found in such fogs are small as compared with concentrations used experimentally to produce acute detectable morbidity or mortality. It was suggested by Cullumbine, that other materials in the atmosphere may potentiate the effects of the known pollutants, or that the individuals affected have been specifically sensitized to these contaminants.

Studies in inhalation toxicity of sulfuric acid, sulfur dioxide, and aldehydes to laboratory animals have shown that a toxicity exists in the range of 8.5×10^3 to 34.2×10^5 milligram-minutes per cubic meter (mg-min/cu.m.) when expressed as concentration times time.

The present study was undertaken to ascertain the influence of kerosene smoke on the effect of sulfuric acid, sulfur dioxide, acetaldehyde, and acrolein. Authors' Abst.

125. Schule, W., and Baum, F.: Investigation of stack emissions by oil-fired boilers with vaporizing burners. Staub 22:200-203 (May) 1962.

Measurements have been made of the waste gas content of oil-fired furnaces with vaporizing burners for the purpose of ascertaining the relationship between the solids component and the Bachrach soot index. It has been found that gravimetric determination of the solids concentration by means of filters suffers interference as a result of the presence of sulfur trioxide in the waste gases. Oil-fired furnaces with vaporizing burners which meet the relevant requirements as regards to soot value (Bachrach index not above 4) have a solids emission not exceeding 15 mg/Nm^3. - English Sum.

126. Schwarz, K.: Sulfur dioxide emissions. Staub 21:71-77 (Feb. 1) 1961.

Sulfur dioxide is among the most important air polluting media. Some examples from numerous measurements show the seriousness of the situation. This makes it essential to exhaust every possibility for reducing sulfur dioxide emissions and, by suitable emission conditions (high chimneys) to ensure sufficient dilution of the effluent gases. In deciding on the means to be employed, meteorological and topographical conditions must be taken into account in addition to operating conditions. The most economic solution will generally be a combination of the various possibilities for reducing the volume of emissions and dilution of the effluent gases. - English Sum.

127. Seczyk, K.: Results of research on air pollution by sulfur dioxide in region of zinc industries in Silesia. Medycyna Doswiadczalna i Spateczna 15:296, 1932.

Gases emanating from zinc and lead foundries in the district of Katowice have been detrimental to the small nearby farms. These foundry gases are composed of particles of ore, coal dust, lead, zinc, sulfur dioxide, carbon dioxide, carbon monoxide, and possibly hydrogen sulfide and arsine. Because there is a limited demand for sulfuric acid, sulfur dioxide is discharged into the air.

Toxic effects of sulfur dioxide on man are described. Low concentrations cause"coughing and symptoms of scratchy mucous membranes of the respiratory passages. High concentrations damage mucous membranes and cause catarrh of bronchi, possibly hemorrhage, and finally inflammation of the lungs." There is apparently no effect on the blood. A permanent worker is not affected in a sulfur dioxide atmosphere, whereas a new man may feel ill.

Study was undertaken "to determine how sulfur dioxide is diluted in the atmosphere and at what radius from the center of production it settles and can act injuriously on people." The manner of carrying out research is described. It was found that a wind of uniform velocity (2 meters/sec.) does not appreciably dilute the sulfur dioxide.

Data are given for many sampling points: distance from the source of sulfur dioxide, concentration of sulfur dioxide, temperature, humidity, wind direction, and concentration of sulfur dioxide found at that point. Rain never favored the disposal of the gases because the concentration was higher in rain than during good weather.

The levels of sulfur dioxide obtained for Silesia were more damaging than those for Pittsburgh.

In fine weather, the sulfur dioxide content for the locality immediately about these foundries was lower than when there was a heavy fog, a low overcast, or rain. The wind played an important role in the distribution of the gases. Weak winds and calms appeared to disperse the gases much better than strong winds. Sulfur trioxide, hydrogen sulfide, and hydrogen fluoride were found in the chimney gases, but not in toxic amounts. - BAAP

128. Sensenbaugh, J.D.: Formation and control of sulfur oxides in boilers. (Coykendall, L.H., Chairman, Committee TA-9, Power Boiler Equipment Information). J. APCA 12:567-591 (Dec.) 1962.

In the combustion of fuels, sulfur is converted essentially completely to sulfur dioxide. A smaller percentage is further oxidized to sulfur trioxide by various mechanisms which are not completely understood; these processes are discussed in the text. Possible control measures are discussed. Removal of sulfur from fuels is limited by economic conditions. Removal of sulfur dioxide from stack gases is technically possible by certain processes, but no economically feasible processes are available. Removal of sulfur trioxide from stack gases by means of additives has been accomplished in some cases. Economic justification may be provided by alleviation of corrosion and deposit problems. - Author's Abst.

129. Shaw, F.M. Sulfur in cupola stack gases. J. Res. & Develop. 6:444-454 (Dec.) 1956.

Figures from original work and other sources used to find proportion of coke sulfur entering metal and slag; results are widely scattered, but indicate that 40-70% of coke sulfur is absorbed by metal and slag, by far greater proportion going into metal; tests on spray type dust collectors indicate that at least one third of sulfur oxides are removed by spray and never reach outside atmosphere. - PHEA

130. Sheehy, J.P., Henderson, J.J., Harding, C.I., and Danis, A.L.: A Pilot Study of Air Pollution in Jacksonville, Fla. PHSP 999-AP-3, USDHEW, PHS, Div. Air Poll., Cincinnati, Ohio, April 1963. 65 pp.

The objectives of the pilot study were to develop a preliminary evaluation of air pollution in Jacksonville and to determine whether the atmospheric concentrations of fluorides and SO_2 were at a level to cause the damages to vegetation which had been reported in the area. The study consisted of an emission inventory, a meteorological investigation, an intensive short-term study of downtown Jacksonville, and an industrial area study. Various programs of air sampling were carried out, including ones for sulfur dioxide, oxidants, nitrogen dioxide, carbon monoxide, hydrogen sulfide, fluorides, and suspended particles. During the study fluoride levels were found to be high enough in certain parts of the city to cause damage to sensitive plants; SO_2 and oxidants were also present at significant levels. Concentrations of SO_2 in 70 samples taken in a downtown park on Aug. 3-10, 1961, ranged from 0.0 to 0.174 ppm., with a mean and median of 0.015 and 0.004 ppm. respectively. During this study 95% of the samples were of less than 0.092 ppm. Although the concentrations of SO_2 observed were generally low, the max. concentration (0.174 ppm.) during this non-heating period can be interpreted as a warning that concentrations could exceed levels that are known to cause damage to susceptible plants, especially during winter months when space heating is necessary. Concentrations of oxidants, recorded in the same study, ranged from 0.000-0.162 ppm. (as hydrogen peroxide), with a mean and median concentration of 0.052 and 0.049 respectively. Of the observations 95% were less than 0.126 ppm. On 5 of the 8 days of the study period, the diurnal pattern of oxidant levels indicated a photochemical type reaction similar to the patterns observed in several other large cities. Results of the study also indicated that pollutants from Jacksonville were being carried across the St. John's River, and finally, that several pollutants constitute a potential problem in the city and should be evaluated further. - APCA

131. Smith, W.S.: Atmospheric Emissions from Fuel Oil Combustion. An Inventory Guide. PHSP 999-AP-2. USDHEW, PHS, Div. Air Poll., Cincinnati, Ohio, Nov. 1962. 95 pp.

This review provides a guide for the inventory and control of emissions arising from the combustion of fuel oil. Information was collected from the published literature and other sources. The report is limited to information on oil used as a source of heat or power (exclusive of process heaters). The data were abstracted, assembled, and converted to common units of expression to facilitate understanding. From these data, emission factors were established that can be applied to fuel oil combustion to determine the magnitude of air-contaminating emissions. Also discussed are the compositions of fuel oils; the preparation and combustion of fuel oil; and the rates of emission, their variables, and their control. - Author's Abst.

132. Smoke and sulfur. Smokeless Air J. Nat. Soc. Clean Air, Summer, 1955, pp. 212-215.

The National Smoke Abatement Society refutes the attack on smokeless fuels, the argument that smoke control without sulfur dioxide abatement would be of little value in minimizing the crippling effects of sulfur-laden atmospheres, and the assertion that N.S.A.S. is supported by vested interests in the production of smokeless fuels. The principal constituents of general urban pollution (in Great Britain) are: (1) the particulate and visible emission composed of sooty, tarry, and oily particles or droplets together with mineral grit and ash particles; and (2) the invisible gases, principally sulfur dioxide, with a little sulfur trioxide, dissolving in moisture to sulfurous and sulfuric acids. That the smoke and sulfur act as a complex is well established. Sulfur may be the chemically active factor, but the smoke and grit particles act as carriers, and possibly as catalysts, and in fog behave as nuclei on which moisture condenses to form droplets in which the acids may dissolve. Thus, the erosion of stonework under the adhesive acid-bearing deposits is one example of conjoint action, and even more striking is the marked acceleration of the corrosion of iron in the presence of carbonaceous particles. Physiologically, synergistic action between smoke particles and sulfur is very probable, both during fog and under normal urban conditions. One must consider also that smoke creates the black smog which, by blanketing solar radiation, keeps the temperature down and extends the period over which the fog may persist. The elimination of smoke and grit will materially lessen the ill effects of sulfur, and on this account alone might be well worth while. And, surprisingly, the critics overlook the serious effects of the visible pollution on health and in numerous other ways, apart from the influence of sulfur. The change to smokeless methods will be met by solid smokeless fuels, by oil, by gas and electricity, and in part by more efficient smokeless combustion of bituminous coal which means lower consumption of coal and reduction of sulfur. - APCA

133. Stern, A.C.: Atmospheric pollution due to gas. Heating & Ventilating 42:73 (Feb.) 1945.

Flue gas is discussed as the principal source of gaseous air pollution in cities. The principal contaminant of flue gas is carbon dioxide, of which the maximum concentration found in cities is 0.04 percent with no known deleterious or objectionable effect upon either plant, animal or human life. Most flues also contain carbon monoxide along with the carbon dioxide, and "carbon monoxide concentrations such as exist in even highly polluted atmospheres are not known to adversely affect either plant life, materials or structures." Other studies have shown that traffic policemen are unharmed by carbon monoxide exposure. Carbon monoxide therefore presents no problem as an atmospheric hazard.

"Although concentration of sulfur dioxide in air over 1 part per million will mark or kill vegetation, those below 0.2 parts per million cause no known damage to plant life." The generally accepted maximum allowable concentration of sulfur dioxide for human exposure is 10 parts per million, which is considerably higher than any atmospheric concentration yet recorded other than in the direct wake of gases from a particular stack. It is conjectured that a concentration of 40 parts per million was reached in the 1930 Meuse Valley disaster. - BAAP

134. Stern, A.C., Editor: Air Pollution. Vol. II. New York. Academic Press, 1962. 586 pp.

Contents: Pt. IV. - Air pollution sources. Combustion in furnaces, incinerators, and open fires. R. B. Engdahl. Automotive exhaust emissions. A.H. Rose, Jr. Mineral and metallurgical industry emissions. J.P. Sheedy and C.A. Lindstrom. Manufacture of the major inorganic acids and alkalis. A.N. Heller. Petroleum refinery emissions. H.F. Elkin. Sources of radioactive pollution. M. Eisenbud. Natural sources of air pollution. A.R. Jacobson. Pt. V. - Control methods and equipment. Process and source control. T. Hatch. Efficiency and selection of collectors. A.C. Stern. Source control by centrifugal force and gravity. K.J. Kaplan. Source control by filtration. C. Orr, Jr. and J.M. Dalla Valle. Source control by electrical, thermal, and sonic forces. C.F. Gottschlich. Source control by liquid scrubbing. W.E. Ranz. Nuisance abatement by combustion. R.J. Ruff. Source control by solid adsorption. A. Turk. Water pollution potential of air pollution control devices. F.E. Gartrell. Pt. VI - Air pollution control. All pollution control administration; planning and zoning. J.J. Schueneman. Air pollution control legislation. S.M. Rogers and S. Edelman. Air pollution standards. A.C. Stern. Source inspection and survey. C. Gruber. Source approval and registration. P.W. Purdom. Public education, cooperation, and voluntary control activities. J.A. Maga. Air pollution personnel. Qualifications and training.

E.T. Chanlett. Pt. VII. Air pollution literature resources. J.S. Nader. Appendix I: List of potential air pollution producing industrial uses and operations. II. Petroleum refinery emission and loss factors. Indexes.- APCA

135. Stratmann, H.: Determination of sulfur dioxide and hydrogen sulfide in the atmosphere. Mitt. V. G. pp. 396-400, 1953.

Sulfur dioxide in the gases and sodium sulfite and acid sulfite in solution are reduced quantitatively to hydrogen sulfide by means of hydrochloric acid-stannous chloride solutions. The H_2S is passed into a sulfuric acid-ammonium molybdate solution, which, by reduction becomes blue in color. Sulfur trioxide is not reduced, and the process is unaffected by other flue-gas constituents. The analysis gives the sum of SO_2 and H_2S. The gas under test is then passed directly into the acid molybdate solution to get the H_2S volume. The difference between the two analysis values gives the concentration of SO_2. However, since the H_2S usually comprises only 1% of the SO_2 concentration, the sum of both concentrations can be treated as the SO_2 value. The colored molybdate solutions are evaluated colorimetrically or photometrically. By this means it is possible to measure H_2S and SO_2 concentrations down to 0.02 mg. per cu. m., with an average error of 6%.

136. Stratmann, H.: Investigations of sulfur dioxide emissions of a pit-coal power station with very high chimneys. Mitt. V.G.B. No. 40, pp. 49-56 (Feb.) 1956.

Determinations of the SO_2 concentration at ground level around a power station with chimneys of 150 M. (490 ft.) height and an SO_2 emission of 0.84 to 1.02 tons/hr. carried out over a yr., have shown that the max. concentrations were generally below 0.5 mg. SO /m^3. the limit above which damage to vegetation may occur. Very occasionally this max. value was exceeded for short times. The max. concentration was found at a distance of between 1500 and 3500M. from the chimney base; the experimental values agreed well with calculated values. The SO_2 concentration varies in cycles with a max. in January and a min. in July. The measurements also showed that the increase of SO_2 concentration caused by industrial plants and populated areas is of the same order of magnitude as that caused by power stations. - APCA

137. Stratmann, H.: Sulfur dioxide emission of a heating power plant in Munich. Staub 19:352-360 (Oct. 1) 1959.

To determine the sulfur dioxide emissions prior to and after starting the operation of a heating power plant air analyses were carried through over a period of three years. The average concentrations (SO_2 level), built up from individual measurings at various measuring points, showed an annually periodic course and rose during the years of observation. Measurements taken for the purpose of comparison in neighboring municipal districts showed that the SO_2 level generally increased constantly, owing to the increasing power demands. As against this, the greater frequency for the appearance of higher SO_2 concentrations, determined out of the spatial-temporal concentration fluctuations, should rather be a result of the start of operating the heating power plant. - PHEA

138. Sulfur flue gases. Chem. Trade. 137:110 (July 8) 1955.

This article contains information on the removal of sulfur compounds from flue gas, from 1954 report of the Director of Fuel Research of the Fuel Research Board.
More sulfur dioxide is emitted in flue gas when boilers are fired with residual fuel oil from petroleum than when coal is used as the fuel. Much of the sulfur is

removed from the flue gas at the coal-fired generating station at Battersea and the oil-fired station at Bankside in London, but the process used is very expensive. A less costly process might be based on scrubbing the gas with a solution of ammonium salts to which ammonia (concentrated gasworks liquor) is added at a rate corresponding to the absorption of sulfur dioxide. Results of the study of this process by the Fuel Research Station are given. - APCA

138c Sulfur-smoke Removal. Bovier, R.F. Presented at the 26th Annual Am. Power Conference. Chicago, Ill., April 16, 1964.

Development of an economically feasible system for essentially eliminating all solids and most sulfur fumes discharged into the atmosphere while burning high ash, high-sulfur content bituminous coal in power plant boilers may solve one of our industry's oldest and most vexatious emission problems. The problem, of course, is how to effectively minimize or control the stack emission of fly ash and sulfur dioxide.

The new system, as developed through actual pilot plant operation, not only promises to successfully eliminate one of the remaining major emission problems associated with the burning of soft coal, but actually produces sulfuric acid of acceptable qualities and in quantities substantial enough for economic commercial use.

The purpose of this paper is to describe the unique system, and how it came about, to explain how it functions, to point out why it appears to be economically feasible, and to indicate its value as an additional major tool for improving the quality of atmospheric conditions in the vicinity of large, new, coal-burning electric generating stations. - Author's Introduct.

139. Sullivan, J.L.: The nature and extent of pollution by metallurgical industries in Port Kembla. (Part I.) In: Air Pollution by Metallurgical Industries, by Bell, A., and Sullivan, J.L. Division of Occupational Health, New South Wales Department of Public Health, Sidney, Australia, 1962, pp. 1:11-1:60.

This report deals with a survey of air pollution in a metallurgical town, Port Kembla, located on the east coast of Australia. Iron and copper ores are smelted and the major emissions consist of solid particles and sulfur dioxide gas. The presence of the latter is most noticeable in the wake of the plume of the stack of the copper smelter during the northeast winds which prevail in summer. In winter the prevailing winds cause industrial pollution to be blown seawards. Tests for sulfur dioxide were made by daily volumetric sampling instruments and a Thomas automatic recorder. The section of the town most severely affected consisted of a swathe of about 200 yards wide and extending to a point where habitation ceased about 0.6 miles from the 200-feet-high stack of the copper smelter. Daily readings of the gas content were not spectacular, the highest being 0.62 ppm. During a little more than three years 24-hour readings of 0.2 ppm or more were measured on 39 days. However, a different picture was obtained from the continuous recorder. This showed that high concentrations of sulfur dioxide tended to occur in episodes of a few hours each. Peaks of greater concentration than 5 ppm were recorded on numerous occasions and the maximum for the sampling period was 13.5 ppm at a point 0.45 miles from the source. Complaints of respiratory distress were made frequently and most householders had ceased to try to grow vegetables. Dust-fall rates measured as water-insoluble solids by a deposit gauge, consisting of a six-inch conical glass funnel and bottle, were high by normal standards. Average annual rates varied between 17.9 and 86.1 tons/mi.^{2}/month. In some locations within a half mile from the edge of the steel industries, the summer dust-fall rates were found to exceed 100 tons/mi.^{2}/month. At one point a mile and a half from the steel industries the monthly rate during 1960 varied between 13.6 and 43.4 tons/mi.^{2}. APCA

140. Tarbutton, G., Driskell, J.C., Jones, T.M., Gray, F.J., and Smith, C.M.: Recovery of sulfur dioxide from flue gases. Indust. Eng. Chem. 49:392-395 (March) 1957.

Flue gas in general is a synthetic mixture of 0.35% SO_2, 3.5% O, 16% CO_2, and 80% N. The recovery of SO_2 from flue gases could be a new source for vast quantities of sulfuric acid or ammonium sulfate. The authors describe in the article a method whereby the manganese-ozone process a maximum concentration of sulfuric acid of 40% was obtained. Dilute sulfuric acid made by the direct manganese-ozone process would have a low sale value. It would need concentration to obtain a valuable acid. Since stack gas must be cooled before scrubbing, its sensible heat might be used to concentrate the acid. The ammonium sulfate process is similar to the direct sulfuric acid process--the reactions are catalyzed by a combination of manganese in the scrubber solution and ozone in the gas. In the scrubber solution it neutralized with ammonia to form a concentrated solution of ammonium sulfate. - PHEA

141. Thomas, F.W.: TVA air pollution studies program. Air Repair 4:59-64, 1954.

The air pollution control program, consisting of preoperational and postoperational phases, carried on by TVA is briefly described. Biological studies of the effect of the emitted SO_2 on the surrounding vegetation are included. Meteorological and air pollution instrumentation is discussed, and methods of reduction and analysis of data are described. Specific examples are cited to illustrate studies on effective stack height and diffusion. Information obtained indicates that the effective stack height and critical wind speed can be estimated with sufficient accuracy for practical evaluation of air poll. control requirements. However, W.T. Ingram and W. Davidson, in their discussion of this paper, state that the critical wind speed and effective stack height are also dependent on the number and type of surrounding structures, as in congested urban areas; F.W. Thomas did not take this into account in his calculations. - KB

142. Thomas, M.D., and Kinney, C.R.: Sulfuric acid in elucidation of coal structure. Indust. Eng. Chem. 55:30-34 (Oct. 24) 1963.

The work described in this article indicates that a substantial part of the carbon is present in aliphatic structures. The sulfuric acid probably reacts with unsaturated bonds to produce hydrogen sulfate and sulfonic acid groups which are mostly aliphatic in nature. Then presumably, the reaction proceeds through decomposition of these groups to give hydroxyl and carbonyl groups which in turn are oxidized to carboxyl groups accompanied by decarboxylation which makes available new unsaturated bonds for further reaction. Thus, the process is repeated.

In the controlled breakdown of bituminous coal in stages, the end products include stable, aromatic nuclei probably related directly to coal structure. If the nature of these nuclei is understood, a better picture of the coal structure may be obtainable.

143. Varlamov, M.L., Manakin, G.A., and Starosel'skii, YA. I.: Purification of exhaust gases of the Tower sulfuric acid system in equipment of the Venturi-Tube type. J. Appl. Chem. USSR (Moscow) 31:172-179 (Feb.) 1958.

Venturi scrubbers installed in spray towers for the removal of sulfuric acid mists and of nitrogen oxides from exhaust gases in sulfuric acid chamber-process plants were tested for performance. The following results were obtained: (1) At a linear gas velocity of 30-75 m./sec. in the venturi tube throat and at a gas-to-liquid vol. ratio of 750-1250, the hydraulic resistance of the tubes was 40-120 mm. H_2O when water was used as an absorption liquid. (2) At a concentration of about

10 g. H_2SO_4/m.^{3} of gas, the degree of absorption of H_2SO_4 spray or mist approached 40%. (3) The relatively low degree of total purification of the exit gases may be attributed to the fact that the nitrogen oxides, which are the main cause of acidity in the exit gases, were not adequately absorbed. And (4) the energy consumption in the purification system studied was found to be 5-6 kw.hr./ton of H_2SO_4. This equals 10-12% of the energy required for the production of sulfuric acid in the chamber process. - APCA

144. Verzar, F., and Evans, H.D.: Production of atmospheric condensation nuclei by sunrays. Geofis. pura e applicata 43:259-268 (May-Aug.) 1959.

Earlier work in another out-of-doors study by Verzar indicated a regular increase of the atmospheric condensation nucleus count on sunny days until midday and a decrease of the count in the afternoon. This finding was confirmed when in the current studies a polyethylene balloon of filtered, nucleus-free air was irradiated by sunlight and an immediate large number of condensation nuclei appeared. The nucleus count rose to about 35000/cm.^{3} but on continued irradiation did not increase but decreased; this decrease was accelerated in the dark. Less intense sunlight, such as that occurring when the sun was covered by clouds, produced a slower and smaller increase. Similar observations were made using industrial oxygen or nitrogen instead of air. Traces of H_2S were found to increase enormously the effect of the sun; traces of NH_3 also increased the count but less than the H_2S; SO_2 filtered through cottonwool was found to be such an intensive nucleus producer that it reacted to produce nuclei even in the dark. It is supposed that H_2S is oxidized by the photochemical action of the sun's visible spectrum to $SO_2 \rightarrow SO_3 \rightarrow SO_4$ which is a nucleus. With NH_3 the formation of $(NH_3)_2SO_4$ is probable. But no direct proof is given that these are the actual impurities which explain the sun's action on air. It is calculated that dilutions of 10^{-15} of an impurity of the type of H_2S can quantitatively explain the effect of the sun. Extensively quoted is the work of Aitken who noticed over 50 yrs. ago the presence of a "fog produced by sun." - APCA

145. Wallis, E.: Atmospheric pollution and the zinc industry. Chem. & Indust. (London) No. 41:1271-1273 (Oct. 8) 1955.

The efforts of the zinc industry to increase production on existing plant have necessitated the solution of two major problems: (1) the improved collection of sinter plant dust; and (2) the treatment of exit gases from contact sulfuric acid plant. Zinc sulfide ores, mainly imported zinc concentrates containing approximately 52% zinc, 31% sulfur, 0.2% cadmium and 1.5% lead, are treated on sintering machines in order to produce a sinter suitable for subsequent treatment in horizontal or vertical distillation plant where zinc will be recovered from the ore. During this operation sulfur dioxide is produced which is converted into sulfuric acid in contact plants. The "sinter" consisting mainly of zinc oxide suitably fritted and in a porous condition favorable for reduction is discharged from the sinter beds at a temperature of 700 and 800°C. The water cooling of this sinter gives rise to a dust-laden atmosphere which requires treatment to recover the metal values of the dust and reduce dust emission. There are many ways in which this may be achieved and the separation may be dry or wet processes. The dry processes are by electrostatic precipitation or by bag filtration; the wet processes are scrubbing towers filled or empty, cyclonic spray towers, venturi scrubbers, etc. Each problem has to be considered on its merits; the size of particle to be removed, the space available for plant and the value of dust against the cost of removal. In many cases the venturi scrubber is believed to give an efficiency of 99% down to a particle size of 0.5 micron and probably 90% at 0.25 micron whereas the cyclonic type has an efficiency of 90% at 1 micron. An attempt has been made to show the energy with which the zinc industry has moved in recent years in its efforts to increase throughputs and improve efficiencies without losing sight of the possibilities of atmospheric pollution. - APCA

146. West, J.R., and Giusti, G.P.: The thermodynamic properties of sulfur dioxide. J. Physical & Colloid Chem. 54:601-605 (May) 1950.

In the petroleum and the chemical industries the use of sulfur dioxide is increasing. At the same time the industries which roast sulfide ores, make sulfuric acid, manufacture sulfur from hydrogen sulfide, and burn sulfur to sulfur dioxide have an interest in the properties of sulfur dioxide at elevated temperatures.

Relatively pure sulfur dioxide may be produced by burning sulfur with oxygen from the tonnage oxygen plants now coming on the market. The combustion may also be carried out under pressure so as to produce, in one operation, a relatively pure compressed gas. Such a process awaits the development of a suitable combustion unit.

Because of the present and possible future need for data on the thermodynamic properties at elevated temperatures, the writers have extended to 2000°F. the information presented by D.F. Rynning and C.O. Hurd (Trans. Am. Inst. Chem. Engrs. 41:265, 1945). Since Rynning and Hurd prepared their article after a critical evaluation of the various publications on this subject, their work is considered the most reliable. The results of the new calculation have been added to those of Rynning and Hurd, so that the tables and graphs shown in this paper are complete and coherent. - Authors' Introduct.

147. Wilkinson, T.J., and Clarke, D.G.: Problems encountered with the use of high sulfur content fuel oils at Marchwood Generating Station and experience with chemical additives. J. Inst. Fuel 32:61-72, 1959.

Problems which occurred with burning a high sulfur content fuel oil in the boilers at Marchwood Generating Station were: corrosion of low-temperature airheaters, severe attack on the precipitator concrete and insulators, grit arrester blockage, ducting corrosion and acidic deposits in the stack. The paper describes experiments with several chemical additives between July 1957, and June 1958, to test their effectiveness in reacting with deposits formed by the constituents of the oil ash and by sulfuric acid, in forming a protective coating on the tube, or in reducing residual SO_3 in the flue gases. Substances injected into various parts of the boiler were: ammonia, two proprietary powder additives, dolomite, a proprietary liquid inhibitor (pyridine), magnesium carbonate and carbon monoxide (town gas). The paper also gives a brief history of the problems, describes modifications to the boilers to improve combustion condition, and includes a general summary of the relative merits of the additives and apparatus developed in conjunction with the additive tests. - Authors' Abst.

148. Wright, R.H.: Reducing sulfate pulp mill odors. Canada 524:764 (May 8) 1956.

Unpleasant odors normally emanating from sulfate pulp mills are reduced by mixing the non-condensable and malodorous gases with an excess of O-contg. gas and bringing this mixt. into close contact with black liquor from the pulp process for a sufficient time to oxidize and absorb the objectionable gases. An app. for this process consisting of vertically disposed parallel sheets is described. - PHEA

149. Yanysheva, N. Ya.: The effect of air pollution from power and chemical plants on health. Gigiena i Sanit. 8:15-20, 1957. In Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U.S. Department of Commerce, Office of Technical Services, Washington, D.C., vol. 1, Jan. 1960, pp. 98-104.

A study was made in 1957 of the effect of industrial discharges on the health of inhabitants of two adjacent communities, one having a relatively clean atmosphere and the other having high levels of air pollution.

A comparative medical study was made of selected groups of adults from each of the communities. In addition 613 children of lower school age were also selected. These groups were studied on a comparative basis with regard to sex, age, duration of residence, type of occupation and general living conditions.

The results showed that morbidity per 100 was 1.8 times as high among the population of community no. 1 than in the control section; there were 81 cases per 100 in community no. 1 and only 45.3 in the control section. Cases of upper respiratory injury among the adults of community no. 1 were twice as numerous as in the control section, and injuries to the nervous system 4.5 as frequent. Diseases of the respiratory tract among the population of community no. 1 were almost entirely limited to the upper respiratory parts.

150. Zieger, E.: The sources, diagnosis, and measures taken against industrial smoke damages to forests. Energietechnik 8:487-490 (Nov.) 1958.

Reforestation with fast-growing coniferous species, particularly fir and spruce, has created single-species forests, which are highly vulnerable as compared to natural, mixed forests. The production of waste gases containing high sulfur dioxide concentrations and their dispersal over wide areas inflict acute and chronic injuries to the above species. The phytotoxical threshold value of spruce for SO_2 lies between 1 and 0.5 ppm.; for fir it is still lower. Under certain circumstances, even pine, which is considered to be smoke-tolerant species, is highly susceptible. Dispersal of waste gases spreads damage over wide areas. Recent increase in the use of powdered coal as boiler fuel has added fly ash as a further threat to plant life. The diagnosis of air pollution damage to vegetation involves 4 basic operations: (1) determination of sulfur concentration in damaged plants, (2) determination of SO_2 content of soil samples, (3) measurement of SO_2 concentration in air samples, and (4) reproduction of prevailing conditions in the laboratory by biological experimentation of fast-growing plants. Other experimental tests in use are the Hartel turbidity test for spruce and spectrophotometric examination of the chlorophyll A/chlorophyll-B ratio. Preventive measures include reforestation with tolerant strains of coniferous trees, and fencing in of coniferous woods with zones of highly tolerant deciduous species. There is hope for regional planning of forests. Expensive improvements of barren soils should be planned carefully since such soils may be reserved for future industrial use. - APCA

151. Zimmermann, R.E.: The atmospheric pollution problem of mine refuse piles. In McCabe, L.C. (editor): Air Pollution. Proceedings of the United States Technical Conference on Air Pollution. McGraw-Hill Book Co., Inc., New York, N.Y., 1952, pp. 73-83.

Waste material from coal mines with its carbonaceous matter and sulfur content is by far the most serious problem compared to rock or tailings waste from other types of mining, and it is with this coal mine refuse waste that this paper is specifically concerned.

Author's experience and present investigation concern a study of coal mine refuse piles, particularly with methods of controlling fires that result from their spontaneous burning or combustion, and with methods of handling coal mine refuse. The Commonwealth of Pennsylvania and the Coal Operators Associations of Western and Central Pennsylvania have established a cooperative research project at The Pennsylvania State College, for the purpose of making an engineering investigation of practical ways and means to handle the refuse from bituminous coal mines so that they will not catch fire and pollute the surrounding atmosphere, or if existing piles are already on fire, effective ways of extinguishing these fires.

The Western Pennsylvania Coal Operators Association has, independently of the state, provided a fellowship at the Mellon Institute for Industrial Research, for the purpose of studying the chemical reactions which bring about obnoxious and deleterious gases and other pollutants from coal mine refuse piles. At this same institute, a private corporation is investigating the possibility of extracting sulfur from coal mine wastes. The United States Bureau of Mines has made and is currently making numerous studies of the mine refuse problem. In addition, many private mining companies are making their own investigations and are actively experimenting with various methods of extinguishing fires or preventing them from starting.

2. EMISSIONS COMPOSITION

152. Adams, D.F., Koppe, R.K., and Jungroth, D.M.: Adsorption sampling and gas chromatographic analysis of sulfur compounds in waste process gases. Tappi 43:602-608 (June) 1960.

A new procedure for source sampling and analysis of malodorous, sulfur-containing gases from the kraft pulping process have been developed The pollutants are absorbed or condensed on activated silica gel at -78.5°C, desorbed under conditions of heat and vacuum, trapped at 195.8°C, and transferred onto a gas-liquid chromatographic column for analysis in a conventional manner using a rising column temperature technique. Water vapor being more polar than the malodorous vapors, must be preferentially removed from the source sample prior to adsorption to prevent chromatographic elution of less polar compounds. The major portion of the water is eliminated by condensation at 0°C and additional water vapor is subsequentially removed on a solid dessicant such as anhydrous calcium sulfate. - Authors' Abst.

153. Arnol'di, I.A. and Velousova, A.Z.: Industrial air pollution in the Noril'sk area. In: Hygienic Problems of Human Adaptation in the Far North,Moscow.Medgiz, pp. 62-67,

Air pollution was noted regularly in the city of Noril'sk (a city north of the Arctic Circle), especially in the older part of the city. Studies showed the pollution levels to be very high in relation to the permissible limits for SO_2 and SO_3. The average amounts of SO_2 (in $mg./m.^3$) at various locations in the city were found to be: 1.34, 1.50 (in the old city), 1.24, 0.78, 0.54, 0.44, 1.13, and 0.55. A considerable amount of pollution by dusts, H_2S, and chlorides was also shown. Average levels of dust (in $mg./m.^3$) at three locations were: 0.64, 0.37, and 0.8. In the precipitated dust was found evidence of cobalt, lead, and several other substances which could not be considered as totally innocuous for humans,when appearing in the air. Interviews with inhabitants of the city indicated a close relationship between air pollution and the sanitary living conditions. The importance of the development of air pollution control systems, is noted. - APCA.

154. Averbukh, T.D., Apakhov, I.A., Maldurova, O.V., Bakina, N.P., Blinova, N.P., Burba, A. A., and Avdeeva, I.V.: Removal of sulfur from waste gases of copper-sulfur plants by total burning. Khim. Prom. pp. 281-288, 1962.

Lab expts. were carried out on the catalytic conversion of the various S-contg. components in the exhaust gases from Cu-S plants to SO_2 or SO_3; the expts. were carried out with synthetic gas mixts. contg. 1-2% of the S-contg. compd., 10% O, and the balance N. H_2S was completely oxidized at 250° on the following catalysts:BA-Al-V (BAV), bauxite, and Ni(or Al) nitrate-on-chamotte; in the absence of catalysts the degree of oxidg. of H_2S at 250° was 70%. COS was completely oxidized only at 500-600° on BAV. CS_2 was practically completely oxidized at 500°, either in the presence or in the absence of catalysts. The degree of oxidn. of the S-contg. compounds was unaffected by variations in the O concn. in the gas mixt., in the range 7-10%, but at lower O concn. an appreciable redn. of the degree of oxidn. was observed. Variations in the particle-sizes of the catalysts (within the range 2-7 mm.) had little or no effect on the degree of oxidn. In all cases the concn. of SO_3 in the product increased with increasing reaction temp. and with increasing initial O concn. in the gas mixt. The linear velocity of the gases over the catalysts was 0.006-0.028 m./sec. Pilot-plant expts. on the oxidn. of the S components in a gas contg. SO_2 0.04-4.16, H_2S 0.34-2.82, COS & CS_2 0.19-1.78, and elemental S 0.08-0.31%, in a mixt. with air, CO_2, and aq. vapors, using BAV as the catalyst, showed that the optimal reaction temp, is 450±10°, corresponding to a degree of oxidn. of the S-components equal to 70-80%. In order to prevent poisoning of the catalyst, any As in the gas was removed in advance. A detailed scheme for the industrial utilization of the oxidized gas by conversion to H_2SO_4 is proposed, and a material and energy balance shows that the process is economically competitive with other processes for H_2SO_4 manufg. - PHEA

155. Batta, G., Firket, J. and Leclerc, E.: Problems of Atmosphere Pollution. Masson et Cie., Paris, 1933.

The authors take up in detail all questions of air impurities. They consider the physical basis for atmospheric pollution, such as the causes and kinds of impurities, the products of combustion, and industrial contaminants. The effects of these impurities on man, as well as on plants, metals, and stone, are described.

One chapter is devoted to a description of the Meuse Valley disaster of December 1930. In this disaster 64 persons died, and a thousand were taken ill. The conclusion was reached that the cause was one of a peculiar meteorological situation plus sulfuric acid formed from sulfurous acids originating from the many industrial plants. Sulfuric acid was named as the chief cause for deaths and illness. Hydrofluoric acid from one plant was considered only a secondary factor. - BAAP

156. Beaver, H., Chairman: Interim report. (British) Committee on Air Pollution. Obtainable from British Information Service, 30 Rockefeller Plaza, New York 20, N.Y., 1954.

The purpose of this interim report is to focus attention upon the crucial factors which will be the subject of further study. There is considerable evidence that the harmful effects of sulfur oxides are enhanced by the presence of smoke particles, and the Committee concludes that the immediate objective should be to prevent the emission of coal smoke, oil smoke, and grit. The complete achievement of this aim in the case of domestic smoke requires the use of smokeless fuels, which are in inadequate supply and will be for some time. Until permanent measures can be introduced, the following emergency measures are recommended: (1) warnings when serious fogs are expected; (2) more frequent measures of pollution, particularly during severe smog; (3) maintenance by householders of a small stock of smokeless fuel for use during fogs; (4) no bonfires or banking of fires during fogs; (5) maintenance of furnaces at high efficiency, and checks of smoke density; and (6) wearing of smog masks by elderly people when outdoors, and reduction of drafts into rooms.

The second part of the report is concerned with a more detailed technical survey of the problem. The effect of smog on health is illustrated by the death rates during the London fog in 1952. The cost of air pollution to the nation justifies the necessarily heavy expenditures for preventive measures. Areas of additional activity in smoke prevention are suggested.

157. Berger, B., Elliott, M.A., Holtz, J.C. and Schrenk, H.H.: Diesel Engines Underground. V. Effect of Sulfur Content of Fuel on Composition of Exhaust Gas. USBMRI 3713, 1943.

The composition of the exhaust gas produced by a commercial Diesel engine operating on a fuel of high sulfur content was determined. Test conditions included operation at minimum speed at minimum, intermediate, and maximum power outputs, and at maximum speed at minimum and approximately 70 per cent of maximum rated power output. Essentially all the sulfur in the fuel appeared in the exhaust gas as sulfur dioxide and sulfur trioxide. The ratio of sulfur dioxide to sulfur trioxide in the exhaust gas varied, increasing temperatures of combustion causing increases in the proportion of sulfur dioxide. No measurable increase was noted in the sulfur content of the engine lubricating oil as a result of operation with the high-sulfur fuel during a limited test period. This statement is made only to confirm the results of exhaust-gas analyses, which showed that with respect to exhaust-gas composition all the sulfur in the fuel may be considered as appearing in the exhaust as sulfur gases. Test results are compared with similar data obtained at comparable operating conditions with a fuel of low sulfur content. Variations in the concentrations of carbon monoxide and oxides of nitrogen may be attributable to differences in the physical characteristics of the two fuels. The test results are discussed in connection with the use of Diesel engines in underground working places. It is concluded that the sulfur content of the fuel for Diesel engines in such application should be limited to 0.3 to 0.4 per cent, as otherwise ventilation requirements would have to be increased to dilute the sulfur gases in the exhaust to concentrations permissible in working environments. - Authors' Sum.

158. Betz, C.E., Holden, J.H., and Handy, J.O.: Sulfur dioxide in air of industrial community. Indust. Eng. Chem. 25:774, 1933.

Results are given, in summary, of daily sulfur dioxide determination in Pittsburgh, Pennsylvania, on the roof of the laboratory. Concentrations for the year varied from 0 to 2.5 parts per million. The highest concentration appeared in morning hours. - BAAP

159. Brasser, L.J., Some aspects of the pollution of the atmospheric air. Mens en Onderneming (Haarlem) 17:136-146 (May) 1963.

Following an historical review of the problem of atmospheric pollution, the various sources of pollution are discussed. The situation in the Netherlands is described in some detail. The country has the advantage of being located so that the prevailing westerly wind comes in over the North Sea and the air is relatively clean. Also the land is flat and the winds are fairly brisk. This favorable, natural condition is often quoted as an argument in opposing the installation of gas cleaning systems. The increasing density of population and industrial development in the western part of the country has resulted in increasing numbers of domestic heating units and increasing automotive traffic. During temperature inversion periods the air pollution levels can become quite serious. In heavily industrialized areas, such as Amsterdam, Zaanstreek (region of De Zaanstreek, near Amsterdam), Ijmond near Rotterdam (Ijsselmonde), and along the Nieuwe Waterweg (New Waterway), the pollution levels are high and steadily increasing. At Ijmond, contamination comes both from the mining activities and from its proximity to the Waterweg. In other locations, such as the mining areas around Limburg, the pollution problem is also one to be reckoned with. In 1958, the T.N.O. (Nederlandse centrale organisatie vor Toegepast-Natuurweten-schappelijk Onderzeek; Netherlands Central Organization for Applied, Natural Science Investigation) made a study of the amount of pollution in the area around the Hague, Rotterdam, Dordrecht, and DeBeer (Rosenburg). Emissions from public utilities and from industry combined, produce a high level of SO_2, but the flue gas emitted from public utilities is also high. A tabulation of these findings is given as follows:

	Tons of pollution/yr.		
	SO_2	Sooty Material	Flue gas
Domestic fires	15,200	7600	2300
Public utilities	28,300	little	6500
Industry	24,200	3100	900
Navigation	1,300	1100	little
Road traffic	900	500	None
Heating of multi-unit buildings	7,400	3000	600

APCA

160. Bushtueva, K.A.: Threshold reflex effect of SO_2 and sulfuric acid aerosol simultaneously present in the air. In: Levine, B.S. (translator): Ryazanov, V.A. (editor): Limits of Allowable Concentrations of Atmospheric Pollutants, U.S. Depart. of Commerce. Office of Technical Services, Washington, D.C., Book 4, 1960, pp. 72-79.

The simultaneous inhalation of sulfur dioxide and of sulfuric acid aerosol in above threshold concentrations elicited reflex changes in eye sensitivity to light and in optical chronaxy, which approximately equalled the sum of changes brought about by the 2 pollutants individually. The simultaneous effect of sulfur dioxide and of sulfuric acid aerosol in concentrations equal to the limits of allowable concentrations correspondingly (0.05 mg/m^3 and o.03 mg/m^3) elicited no changes in the curves of adaptation to darkness or in the optical chronaxy curve of man. The results indicated that the synergistic effect of sulfur dioxide and sulfuric acid aerosol simultaneously present was active only in concentrations which exceeded the limits of allowable concentrations previously adopted. Therefore, it is concluded that, even in the simultaneous presence of the 2 pollutants in the atmospheric air, the limits of allowable concentration previously adopted for each of the substances can safely remain in effect.

161. Cappuccilli, P.: Modern views on atmospheric pollution. Ann. Med. Nav. (Rome) 66:613-632 (Sept.-Oct.) 1961.

The importance and need for further studies on air pollution, are stressed. The causes of pollution are of 2 principal kinds: those common to all large urban centers due to the exhausts from industrial plants and from motor vehicles, and those occuring at some particular sites due to local industrial or other special activities. In Italy in 1950 there were 1,297,000 automotive vehicles being driven; in 1959 this had increased to 5,755,673. In this brief span of 10 yrs the increase was of about 6 times for motor vehicles and motorcycles, about 5 times for motor coaches, and about double for lorries. In Los Angeles, over a period of 5 yrs. with 3 million automotive vehicles in use, the amount of atmospheric contaminants discharged daily was about 2,700,000 kg., this being attributable to exhaust gas from motors of internal combustion. Materials present in exhaust gas are primarily carbon monoxide, fine carbon particles, incomplete and partially burned hydro-carbons, nitrogen oxides, aldehydes, acids, peroxides, sulfur dioxide, and lead chloride and bromide from the tetraethyl lead content of the gasolines. The amounts of these substances emitted to the air depends on the running speed and efficiency of the motor. Gasoline in Italy contains no more than 0.20% of sulfur and diesel oil no more than 1.25%. When 1 kg. of gasoline is burned the content of 10 g. of sulfur forms 20 g. of SO_2. A liter of gasoline, ethylated at 0.5%, produces 0.35 g. of lead. The possible harmful effects of air pollution on man are mentioned and several suggestions - such as reducing motor vehicle emissions, decentralizing industry, and separating industrial and residential areas - for control of air pollution are made. - APCA

162. Chakraborty, M.K., and Rao, M.N.: Atmospheric pollution: A study in Calcutta. Indian J.M.Res. (New Delhi) 50:295-318 (March) 1962.

Calcutta is one of the heavily industrialized cities in the East; it is also a densely populated city. This study of air pollution in and around Calcutta, during the period of 1955 to 1958, includes estimations of the important air contaminants in Calcutta and Howrah. A comparative study is also reported of the corresponding conditions in rural Bengal. As the study was over a period of time, season and diurnal fluctuations in air pollution could be observed. The following summarizes the extent of pollution observed in Calcutta:

Soot fall	39.38 - 90.98 tons/sq. mi./month
Sulfur dioxide	0.021- 0.058 ppm
Oxides of nitrogen	0.043- 0.122 ppm
Ammonia	0.160- 0.266 ppm
Aldehydes	0.04 - 0.12 ppm
Respirable dust	0.071- 0.600 mg./m^3/of air

The paper discusses how air pollution can be tackled as a public health problem. In conclusion the authors recommend that India would be well advised to be forewarned of the dangers of air pollution and of the need to develop a suitable national control policy especially to cover the industrial area. Meanwhile, however, the existing air pollution control program in Calcutta has to be severely modified and intensified. - APCA

•163. Cuffe, S.T.: Air pollutants from power plants. Techniques for evaluating air pollutants. Arch. Environ. Health 6:422-427 (March) 1963.

Information in the literature concerning air pollutant emissions from coal-fired power plants is very incomplete. With the exception of some data on sulfur dioxide and smoke emissions, published information is limited almost wholly to fly-ash concentrations. The effects of method of operation, type of boiler furnace, and type of coal on formation of air pollutants and on stack emissions should be determined. This information would be helpful in evaluating methods for reducing air-pollutant emissions. For these reasons the United States Public Health Service and the United States Bureau of Mines are jointly conducting an intensive study of emissions from large coal-fired power plants, an important source of air pollution in most industrial complexes.

The objective of the study is to evaluate the emissions of oxides of nitrogen, oxides of sulfur, polynuclear hydrocarbons, total hydrocarbons, total solids, formaldehyde, organic acids, and common metals in the gases emitted from various types of coal-burning power plants which may be useful in establishing the range of atmospheric emissions under various conditions of operation. Determination of the efficiencies of control equipment is also essential for the long-range objective of reducing total air pollution.

This paper describes the sampling and analytical techniques used in evaluating the several types of emissions under study. - AGC

164. De Bary, E., and Junge, C.E.: Distribution of sulfur and chlorine over Europe. Tellus 15:370-381 (Nov.) 1963.

In air pollution studies, it is of interest to know the background concentration of some constituents in a large area.

Maps showing the mean concentration of sulfur and chlorine in air and precipitation over north-western Europe in summer and winter have been constructed. Excess SO_4-S has been computed on the assumption that chloride is a conservative property of sea spray particles and that there are no other sources for chloride than sea spray. Maps showing the ratio of concentration of air/precipitation for sulfur and chlorine are presented. - PHEA

165. Diem, M.: Measurements of dust deposition from the chimneys of an industrial plant on the Lower Rhine. Mitt. V.G.B.42:201-223, 1956.

The results of measurements of dust and sulfur dioxide deposition over a period of 6 months, are given in graphs and tables. The average deposition of dust was 6g/sq.m/month, the max. in the neighborhood up to 12g./sq.m./month, and inside the works

20g./sq.m./month. Sulfur dioxide deposition was between 4 and 8 mg./100 hr. at the observation posts. From observations made in a special test it has been deduced that at low wind velocities (0 to 0.6m/sec.) the max. sulfur dioxide deposition was 0.15mg./m^3 at a distance of 1400 m. and at higher velocities (0.9 to 3.2m/sec.) it was 0.22mg./m^3 at a distance of 1000m. from the chimney base. The theoretically calculated and observed results of the distribution of deposition of dust and sulfur dioxide agreed fairly well. The subjective observation of a smoke plume is shown to be useless; a method of taking stereoscopic photographs has been developed which permits an exact evaluation of the plume height, spread and dissolution. - APCA

166. Discussion on "The Beaver Report". J. Inst. Fuel 28:175-198 (April) 1955.

The amelioration of air pollution is mainly a problem in fuel technology, the problem of how to deal with large local emissions of flue gases containing sulfur oxides, and the problem of removal versus dispersion. The most immediate problem is to prevent the occurence of smoke, grit and dust. Recommendations on smoke elimination are divided into (1) industrial and (2) domestic. The industrial problem involves putting coal-burning plants into a sound condition, soundly operated; and those who handle industrial combustion equipment should be trained in its use. The domestic problem entails local option as to whether a zone shall be declared "smokeless" or "smoke controlled", or not. This ultimately is for each local authority. Evidence put before the Beaver Committee suggested that in the presence of smoke, sulfur dioxide is far more virulent, in the effect on health and materials, than when smoke is absent. Apart from sulfurous gases, smoke is harmful. One of the unsolved problems in air pollution is that there is no clear assurance that sulfur will be injurious once smoke is removed. Dust extraction is a subject to which much attention must be given; dust could be as harmful as smoke. All aspects of atmospheric pollution resulting from the combustion of coal were discussed. The Committee stressed the importance of establishing a clean air council. - APCA

167. Dubrovskaya, F.I.: Hygienic evaluation of pollution of atmospheric air of a large city with sulfur dioxide gas. In: Levine, B.S. (Translator): Ryazanov, V.A. (editor): Limits of Allowable Concentrations of Atmospheric Pollutants. U.S. Depart. of Commerce, Office of Technical Services, Washington, D.C., Book 3, 1957, pp. 37-51.

A study was made of the degree and extent of Moscow air pollution with sulfur dioxide. It should be noted in this connection that the limit of allowable concentration of SO_2 previously adopted by the Chief Sanitary Inspection of the U.S.S.R. at the recommendation of the Committee on Allowable Concentration Limits of Air Pollutants was of a temporary character and that one of the aims of this study was to check the correctness of that recommendation. The limit of allowable SO_2 concentration recommended by the Committee was arrived at by determining its threshold action on plants, which was 0.9 mg/m^3 for short and 0.5 mg/m^3 for long time exposure, and its threshold odor perception by man, which was 4 mg/m^3.

The re-examination was limited to short time maximal single SO_2 concentration exposures. Two methods were employed: 1) determination of the threshold of odor perception; 2) determination of SO_2 threshold reflex effect on the sensitivity of the optical light analyzer. A special assembly was used in the determination of SO_2 threshold of odor perception which made possible the maintenance of constant SO_2 concentrations during test observations. Odor perception threshold tests were made on 12 persons paralleled by control tests. Most test subjects were of an age at which, according to reports in the literature, odor perception was at its highest. Sulfur dioxide concentrations of 0.5 up to 13 mg/m^3 were used in 530 threshold determinations.

168. Flint, D., Lindsay, A.W., and Littlejohn, R.F.: The effect of metal oxide smokes on the sulfur trioxide content of combustion gases from fuel oils. J. Inst. Fuel 26:122-127 (Sept.) 1953.

Quantitative data were obtained on the influence of various additives to the fuel burned as a method of decreasing the quantity of sulfur trioxide. Measurements on the gases from the heavy fuel oil treated with (1) soda residue, (2) calcium residue, and (3) commercial zinc naphthenate showed that the last alone was successful in decreasing greatly the amount of SO_3. Under good combustion conditions the dew point indicated no SO_3 when oil containing 0.14% zinc was burned. With 0.07% zinc the amount of SO_3 was still very low, as shown by a dew point of 160°F.-Authors' Sum.

169. Foster, W.W.: The size of wood smoke particles. Internat. J. Air Poll. (London) 3:89-96 (Oct.) 1960.

The smoke generated when wood is heated in air contains a considerable range of compounds resulting from the distillation and degradation of the celluloses, lignins, resins, and tannins. Visible particles which are formed when the smoke cools appear to equilibrate rapidly with the ambient vapors. In the present experiments smoke was generated by agitating sawdust fed into a blast of air which was at a temperature of 314 ± 2°C. Smoke cooled down to room temperature was sampled in 3 ways, by means of a cascade impactor; by gravitational settling in a chamber about 10 cm. high; and by an electrical method. The measurement of the rate of coagulation of charged aerosols is difficult, chiefly because the particles disperse rapidly on the containing walls. Although the results presented cannot be considered to be conclusive, it would seem that the method of determining the average radius of charged aerosols might be useful when studying their coagulation, especially when applied to aerosols initially monodisperse or of known size distribution. - APCA

170. Friberg, L., Jonsson, E. and Cederoflof, R.: Studies on the sanitary nuisance of smoke-gases from a sulfate cellulose factory. I. An interview study. Nord. Hyg. Tidskr. 41:41-50, 1960.

This article presents the results of an interview study covering about 400 persons selected at random from the population living within 20 km. of a sulfate cellulose factory. The main purpose of the investigation was to study the inconvenience caused by air pollution from the factory. The "sulfate smell" disturbed 36% of those interviewed, and 1/3 of those interviewed described their discomfort as severe. Despite the complaints only 5% considered it disadvantageous that the factory was situated in the tract. Comparisons between different parts of the area investigated indicated the existence of a correlation between the situation of the residence of the individual interviewed in relation to the factory and the comparative incidence of persons disturbed. The investigation showed that certain groups of people were more discomforted than others. Women were disturbed more than men and younger more than older. Moreover, there was some relation between the discomfort caused by the odor and discontent. It was also evident that persons disturbed by the sulfate odor complained about the odor from the factory in the area to a greater extent than persons not disturbed by the sulfate odor. - Authors' Sum.

171. Gartrell, F.E., Thomas, F.W., and Carpenter, S.B.: An interim report on full-scale study of dispersion of stack gases. J. APCA 11:60-65 and 96 (Feb.) 1961.

The Tennessee Valley Authority in co-operation with the U.S. Public Health Service initiated in July 1957 a full-scale study of diffusion of stack gases from large coal-burning power plants. Three-dimensional measurements of dispersion are made by aerial sampling of SO_2 with a Titrilog operated in a helicopter. This report describes equipment and sampling plans. Data from sampling of eight inversion plumes, along with the results of preliminary analyses of these data, are presented. Apparent losses of SO_2 from the plume with time and distance from the source are cited. Preliminary investigations of this finding by means of controlled dilution and cooling of flue gas pointed to oxidation of SO_2 as a possible explanation. - Authors' Sum.

172. Gartrell, F.E., Thomas, F.W., and Carpenter, S.B.: Atmospheric oxidation of SO_2 in coal-burning power plant plumes. Am. Indust. Hyg. A.J. 24:113-120 (March-April) 1963.

Sampling equipment and procedures applicable for use in a helicopter were devised for collecting the separate SO_2 and SO_3 components in progressive plume cross sections at a large coal-burning power plant. Samples were collected during a variety of meteorological conditions with particular attention to a wide range of relative humidity. During periods of low humidity, data reveal that oxidation of SO_2 is relatively slow, increasing from 2% at one mile (12 minutes) to 3% at 6 miles (60 minutes). With moderately high humidity, oxidation was initially rapid, 22% at one mile (12 minutes), increasing to 32% at 8 miles (96 minutes). The highest total oxidation, 55%, was observed in a slight mist at 9 miles (108 minutes). - Authors' Abst.

173. Guthmann, K.: The problem of "Maintaining Air Purity" with special consideration to iron foundries, especially the steel works industry. II. Dust removal from waste gases of the Siemens-Martin Oven. Staub 19:123-124 (Apr.) 1959.

The second part of this survey report deals with the major foreign experiences in removing dust from the waste gases of the Siemens-Martin oven. Detailed information is given concerning the discharge, waste, concentration, and chemical composition of the waste gases and flue dust of this oven. The particle size lies for the most part (e.g. 80%) below 0.8 microns. The waste gas compares very favorably in this respect with brown converter smoke.

The amount of waste gas is approximately 3500 cubic meters per ton of crude steel production. Only about 4% of the sulfur in the charge (scrap) of the smelter oven goes into the waste gas. The dust discharge of the Siemens-Martin oven is approx. 0.45-2% of production, corresponding to 4.5-20 kg/t crude steel. The waste gases have the following composition: 8-20% CO_2; 0-5% O_2; 0-8% $CO + H_2$; 0-8 g sulfur/m^3; Remainder N_2.

According to the composition of the scrap which is added, the flue dust itself has many metal and metal-oxide impurities; for example, up to 23% lead, up to 45% zinc and up to 65% iron. Numerous analyses from various sampling outlets on the oven are reported.

The industrial experiences of American steel works with dust removal equipment of various types are discussed in detail on the basis of the aforementioned data and publications, and approx. 20 different dust removal methods are cited. For separation of waste gases the following have proved successful: scrubbers, such as the Pease-Anthony_Venturi Scrubber; tube filters; mineral wool filters; and, more recently, the electrofilter. These purify the waste to approx. 100-200 mg/m^3 waste gas. 21 tables. 15 figures. 51 references. - PHEA

174. Haagen-Smit, A. J., Taylor, V.D., and Brunelle, M.F.: Spectroscopic analysis of industrial emissions for nitric oxide. Nitrogen dioxide and sulfur dioxide. Internat. J. Air Poll. 2:159-166 (Oct.) 1959.

Together with smoke density meters, the automatic recording NO and SO_2 meters are valuable tools in the prevention of excessive emissions of air pollutants in flue gases. The NO, SO_2 recorder makes available a research tool for the study of formation and controls of oxides of nitrogen and sulfur. The close relation between flame temperature and NO formation should open the way for interesting studies in plant operation. The removal of excess water, dust, and sulfuric acid from the flue gas by condensation and electrostatic precipitation is of general application, and has led to a more disturbance-free operation of many different types of automatic instruments such as sulfur dioxide, nitric oxide, carbon monoxide, carbon dioxide, and oxygen analyzers. - Authors' Abst.

175. Harlow, W.F.: The formation of sulfuric acid in boiler flue gases. ASME Trans. 80:225-234 (Jan.) 1958.

The results of the work described in this paper confirm the conclusions previously recorded that the formation of the sulfuric acid which affects boiler-plant operation is a surface effect which occurs mainly on the heating tubes, particularly the superheater; and that formed in the combustion process, is unimportant. Some formation can take place on furnace walls but in boilers with large combustion chambers this is small compared with that formed elsewhere. The effect can be controlled and prevented for considerable periods by surface treatment of the tubes, both metallurgical and chemical. More progress could be made in the avoidance of boiler deposits and corrosion by preventing the acid formation than by dealing with its effects, thereby obviating at the same time a serious source of atmospheric pollution. -APCA

176. Heimendahl, P.V.: Dust and SO_2 discharge and residue from combustion from steam power stations in the German Federal Republic. Mitt. V.G.B. No. 87, pp. 409-415 (Dec.) 1963.

Investigations carried out by the V.G.B. by direct questionnaires to determine practical values of p.f. ash and SO2 discharge are discussed and the results presented in table form. Efficiency of gas cleaning and figures for total slag p.f. ash and granulate from hard coal and brown coal are given.

177. Hendrickson, E.R., Walker, C.G., and Chapnerkar, V.D.: Identification of non-sulfur organic compounds in stack gases from pulp mills. Am. Indust. Hyg. A.J. 24:121-126 (March-April) 1963.

Objectionable odors of stack emissions from pulp mills have been traditionally associated with sulfur compounds. Concentrations of identified sulfur compounds are not considered dangerous to health of the community. In this study of stack gases, qualitative identification has been made of the presence of: benz/a/-anthracene, benzo/a/pyrene, benzo/e/pyrene, benzo/g, h, i/perylene, chrysene, coronene, fluoranthene, and pyrene. Tentatively identified were: anthanthrene, anthracene, phenanthrene and vanillan. - Authors' Abst.

178. Jarvis, W.D., and Austin, L.G.: Routine surveys of atmospheric pollution by dust and sulfur dioxide around power stations of the central electricity authority. J. Inst. Fuel (Aug.) 1957.

This paper gives details of a number of atmospheric pollution surveys which have been carried out by the Central Electricity Authority to observe changes in the level of dust deposition and sulfur dioxide pollution in the neighborhood of modern power stations when the power stations were put into operation. The results so far obtained show that the increase in the rate of dust deposition within a radius of two miles of a power station is small. The average concentration of sulfur dioxide at ground level had shown a trend towards a small increase with increasing power station output, but changes which occurred in the background levels of sulfur dioxide concentrations during the period of the surveys do not allow a significant conclusion to be drawn. The results suggest that other methods of measuring small changes in the concentration of sulfur dioxide should be considered. - Authors' Abst.

179. Kanno, S.: The colorimetric determination of sulfur oxides in atmosphere. Internat. J. Air Poll. 1:231-233 (Jan.) 1959.

In air pollution studies on the presence of sulfur oxides it is necessary to determine both SO_2 and SO_3 at the same time and place, for both sulfur oxides are present simultaneously. Barium chloranilate was applied to the determination of sulfur oxides in air. The hydrogen peroxide method for determining the total sulfur oxides and the lead peroxide method for measuring the extent of atmospheric pollution by sulfur oxides were simplified. The latter especially is convenient for the detailed observations of air pollution by sulfur oxides, as the test period can be shortened to 10 days. - Authors' Concl.

180. Katz, M., and Cole, R.J.: Recovery of sulfur compounds from atmospheric contaminants. Indust. Eng. Chem. 42:2258-2269, 1950.

The emission of sulfur compounds recognized as major atmospheric contaminants, must be reduced as a matter of economics and in the interest of public welfare. Great strides have been made in the control of smelter smoke damage by scientific investigation of sulfur dioxide injury to plant life, and the application of remedial measures, which include use of high stacks and high temperatures for the discharge of waste gases, continuous automatic measurement of ground concentrations and application of meteorological control by accurate forecasting of critical weather conditions, and installation of recovery plants for conversion of excess sulfur dioxide to liquid sulfur dioxide, sulfuric acid, fertilizers, or elemental sulfur. The annual losses of sulfur from products discharged to the atmosphere from zinc plants, lead, copper, and nickel smelters, crude oil refineries, and from coal combustion, are compared with world native sulfur production and by-product sulfur recovery. The extent to which sulfur emission must be reduced, to avoid injury to plant life, is discussed in terms of the permissible levels of ground concentration. Methods for recovery of sulfur compounds from sulfur dioxide and hydrogen sulfide in stack gas include concentration of sulfur dioxide and its conversion to sulfuric acid, recovery as elemental sulfur, and flue gas disposal of the effluent and non-effluent types. New developments of outstanding importance for purification and recovery of sulfur dioxide are embodied in the Trail ammonia process, the dimethylaniline process at Selby, and flash smelting at Copper Cliff in conjunction with liquid sulfur dioxide recovery. An aroused public consciousness of the need of controlling atmospheric pollution has stimulated investigation in many contaminated areas. Sulfur contaminants may be profitably recovered in many industrial operations and thus clean up the air and add to native sulfur reserves, which are rapidly being depleted in the United States. More research is needed in industries confronted with difficult recovery problems - for example, nickel smelters. Cooperation between major native sulfur producers and companies with a large sulfur problem on their hands is desirable. - Authors' Abst.

181. Kuwabara, T.: Investigations of waste gas discharged from a copper melting kiln. Heat & Management (Tokyo) 12:9-14 (June) 1963.

From the copper melting kilns, in a copper mining station, the Pb (which was added in the charging of the kiln), Sb, As, Bi, Te, and Se which are 1st vaporized into the element state, are discharged as dusts together with the CO_2 and SO_2 which have been produced in the process. Ag and Au are also contained in the dusts but in a very small quantity. Discharges are released through an underground flue which is connected to a chimney. Much of the pollutant material precipitates out at the end of the flue, and some has already been recovered within the processing, but a considerable amount is discharged to the surrounding atmosphere from the stack. Gas and dust sampling carried out over the period of Feb. 27-28, 1962, indicated that the total dusts amounted to 3.35 tons/month, 1.7 tons of which were recovered, but 1.6 tons of which were emitted from the stack. Problems concerned with methods necessary to improve the situation are as yet unsolved. - APCA

182. Larsen, R.I.: United States air quality, A.M.A. 8:325-333 (Feb.) 1964.

Particulate pollutant parameters are given for 20 particles measured in United States urban air. Gaseous pollutant parameters are given for sulfur dioxide concentrations measured in Chicago, Cincinnati, Los Angeles, Nashville, New Orleans, Philadelphia, San Francisco, and Washington. Data for carbon monoxide and nitrogen oxide concentrations in some of these cities are also presented. Pollutant concentration is related to city size and distance from city center. Sulfate particulate concentration is related to sulfur dioxide concentration. Pollutant concentrations are discussed in terms of relative effects and absolute units.

Means are presently available or are being developed to control the emission of all these pollutants, except the nitrogen oxides, which come from all combustion sources. There is no known easy method for controlling nitrogen oxides. In the decades ahead, the ultimate solution to pollution from nitrogen oxides as well as the other pollutants may be the greatly reduced use of high-temperature combustion in homes, vehicles, and industry. Fuel cells and atomic fission or fusion might then power the nation electrically. - PHEA.

183. Lombardo, J.B.: Analysis of sulfuric acid contact plant exit gas: Critical Review of Analytical Methods for Acid Mist and Sulfur Dioxide. Anal. Chem. 25:154-160 (Jan.) 1953.

A critical and extensive review of the literature on the analysis of sulfuric acid contact plant exit gas for the two important constituents, sulfuric acid mist and sulfur dioxide, disclosed the lack of a practical analytical method. Such a method is essential for the proper control of the process and evaluation of air pollution. Sulfuric acid mist in the range of 0.1 to 10 mg. per cu. ft. is determined by filtering the particles on a specially designed sintered glass unit; sulfur dioxide in the range of 1 to 100 mg. per cu. ft. is determined by oxidation by and absorption in hydrogen peroxide and subsequent titration with sodium hydroxide. The application of the proposed method has contributed materially to the intelligent control of a modern sulfuric acid contact plant. - Cond. Authors' Sum.

184. MacPhee, R.D., Taylor, J.R., and Chaney, A.L.: Some data on particulates from fuel oil burning. J. APCA 10:7-13 (Feb.) 1960

This paper describes long-term pollution trends as measured by the Los Angeles air monitoring network. The monitoring is done with 24-hr. recording devices. A by-product of this operation is the generation of data from which the levels and trends in pollution can be studied. The findings are as follows: (1) During the 3 yr. period, 1956-59, the general level of carbon monoxide has been rising. The rise of

CO of 1 ppm./yr. has not been reconciled with weather of other pollution factors. The rise in nitrogen dioxide was small and trends are available only from 1957. Sulfur dioxide varied slightly without changing its general level. (2) In examining the monthly average data used as the basis for the trend lines, it was observed that certain contaminant and weather factors could be grouped together. Both the yearly and the diurnal cycles confirm the distinction between types 1 and 2 pollutants. - APCA

184c Mader, P.P., Heddon, N.W., Eye, M.G., and Hamming, W.J.: Effects of present-day fuels on air pollution. Indust. Eng. Chem: 48:1508-1511 (Sept.) 1956.

Individual olefins were tested for their oxidation capacity. Test data indicated that internal double bond olefins, as well as branched chain a-olefins, are readily oxidized upon irradiation with sunlight in the presence of oxides of nitrogen.

Comparisons made between thermally and catalytically cracked gasolines indicated that the present-day gasolines showed a marked increase in internal double bond olefins and in branched chain a-olefins. Internal double bond olefins increased 117.8%, branched chain a-olefins increased 73.2%.

The quality improvement of our present, powerful fuels is in part due to the substantial increase in internal double bond olefins and branched chain olefins which they contain. This change in composition, however, may be only one of the factors which contributes to the smog intensity.

While the total loss of gasoline vapors into the atmosphere has been estimated at 400 tons per day, the contribution of automobile exhaust hydrocarbons was calculated to be close to 1200 tons. Only after all contributing factors have been analyzed and are accounted for will it be possible to determine more accurately the effects of fuel composition on air pollution. - Authors' Sum.

185. Nai, G., and Kochetkova, T.A.: Experimental investigations of the effect produced by pyrite dust. Arkhiv patologii, 23:51-56, 1961.

Experimental investigations have demonstrated the possibility of the specific action of pyrite dust (Fe_2S), when subjected to oxidative processes, of forming sulfuric acid and thereby exerting a toxic effect on contact with a fluid media. Pyrite dust is a frequent admixture of coal and ore dust in mines. Inhalation of oxidized sulfur compounds may well aggravate the action of other, not too toxic, dusts. - APCA

186. Plotnikova, M.M.: Basic investigations for the determination of the limit of allowable acrolein concentration in atmospheric air. In: Levine, B.S. (translator): Ryazanov, V.A. (editor): Limits of Allowable Concentrations of Atmospheric Pollutants. U.S. Depart. of Commerce, Office of Technical Services, Washington, D.C. Book 4, 1960, pp. 59-72.

0.8mg/m^3 of acrolein was the threshold level of its odor perception by most sensitive persons. The threshold of acrolein reflex effect on optical chronaxy is at the level of 1.75 mg/m^3; on rhythm and amplitude of respiratory movement it was 1.5 mg/m^3. The threshold of acrolein reflex effect on eye sensitivity to light, as determined by the adaptometric method, was at the 0.6 mg/m^3 level, which is below the threshold level of its odor perception. Therefore, it is suggested that the maximum single limit of allowable concentration in atmospheric air, after making allowance for safety, be set at 0.3 mg/m^3. The investigation herein reported showed that the limit of allowable concentration of acrolein set at 2 mg/m^3 for air of working departments caused irritation of the conjunctiva and nasal mucosa, lowered eye sensitivity to light, as well as optical chronaxy and elicited changes in the rhythm and amplitude of the respiratory movements; therefore, it is suggested that the appropriateness of the official limit be restudied, with a view to its lowering. Results of the studies herein reported also showed that the atmospheric air surrounding the investigated oil drying plants contained acrolein concentrations in excess of the allowable limit even at 1,000m from the plant. Therefore, it is suggested that the sanitary clearance zone between oil drying plants and residential sections be set at 1,000m, even when the plants are equipped with gas purifying installations.

187. Popov, I.N., Cherkasov, Ye. F., and Trakhtman, O.L.: Determination of sulfur dioxide odor threshold concentration. Gigiena i Sanitariya, No. 5, pp. 16-20, 1952, in: Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U.S. Dept. of Commerce, Office of Technical Services, Washington, D.C., Vol. 3, (May) 1960, pp. 102-106.

The All-Union Sanitary Control Office appointed a special Committee of representatives from hygienic institutes to determine maximum allowable concentrations of pollutants present in the atmospheric air. The Committee prepared two concentration standards for sulfur dioxide: a maximum single dose of 0.75 mg/m^3 and an average daily concentration of 0.25 mg/m^3. The authors of this report undertook to find the threshold concentration of olfactory sensitivity to sulfur dioxide in atmospheric air, to determine its relation to the recommended standard maximum concentration of sulfur dioxide in the air, and to ascertain whether the odor receptor apparatus could be used in the control of concentrations of noxious odor-emanating gases in the air.

Soviet hygienists regard freedom from odor as a basic requisite. The present sanitary regulations prescribe 0.25 mg/m^3 as the maximum daily average SO_2 concentration and 0.75 mg/m^3 as the maximal single SO_2 concentration in atmospheric air. Results of this investigation show such concentrations to be above the threshold of SO_2 odor perception. It is suggested that they be replaced by results of more recent and more sensitive studies.

188. Schueneman, J.J., High, M.D., and Bye, W.E.: Air pollution aspects of the Iron and Steel Industry. PHSP No. 999-AP-1. USDHEW,PHS, Cincinnati, Ohio, (June) 1963.

This report is a summary of published and other information on the air pollution aspects of the iron and steel industry, including coke plants incident thereto. Processes, equipment, and raw materials are briefly described. The magnitude and location of plants and process trends are noted. Air pollutant emissions and means for their control are discussed in detail, with respect to sintering; coke production; blast furnaces; open hearth, Bessemer, electric, and basic oxygen steel-making furnaces; and other operations. The effects of pollutants on community air quality are described, and knowledge of health aspects of pollutants is summarized. Laws regulating pollutant emissions are given, and control equipment and measures needed to comply with certain laws are listed. - Authors' Abst.

189. Sheehy, J.P., Henderson, J.J., Harding, C.I., and Danis, A.L.: A pilot study of air pollution in Jacksonville, Florida, PHSP No. 999-AP-3. USDHEW, PHS, Cincinnati, Ohio. (April) 1963. 65 pages.

The objectives of the pilot study were to develop a preliminary evaluation of air pollution in Jacksonville and to determine whether the atmospheric concentrations of fluorides and sulfur dioxide were at a level to cause the damages to vegetation which had been reported in the area. The study consisted of an emission inventory, a meteorological investigation, an intensive short-term study of downtown Jacksonville, and an industrial area study. Various programs of air sampling were carried out, including ones for sulfur dioxide, oxidants, nitrogen dioxide, carbon monoxide, hydrogen sulfide, fluorides, and suspended particles. During the study fluoride levels were found to be high enough in certain parts of the city to cause damage to sensitive plants; sulfur dioxide and oxidants were also present at significant levels. Concentrations of sulfur dioxide in 70 samples taken in a downtown park on August 3-10, 1961, ranged from 0.0 to 0.174 ppm, with a mean and median of 0.015 and 0.004 ppm, respectively. During this study 95% of the samples were of less than 0.092 ppm. Although the concentrations of sulfur dioxide observed were generally low, the maximum concentration (0.174 ppm) during this non-heating period can be interpreted as a warning that concentrations could exceed levels that are known to cause damage to susceptible plants, especially during winter months when space heating is necessary. Concentrations of oxidants, recorded in the same study, ranged from 0.000 to 0.162 ppm (as hydrogen peroxide), with a mean and median concentration of 0.052 and 0.049 respectively. Of the observations 95% were less than 0.126 ppm. On 5 of the 8 days of the study period, the diurnal pattern of oxidant levels indicated a photochemical type reaction similar to the patterns observed in several other large cities. Results of the study also indicated that pollutants from Jacksonville were being carried across the St. John's River, and, finally, that several pollutants constitute a potential problem in the city and should be evaluated further. - APCA.

190. Stenburg, R.L.: Status of the flue-fed incinerator as a source of air pollution. Am. Indust. Hyg.A.J. 24:505-516 (Sept.-Oct.) 1963.

Flue-fed incinerators are discussed as a source of air pollution. Design and operating factors responsible for the air pollution problems are presented with alternative modifications for improvement. Recommendations are included for modification of existing units and improved design of new installations. Alternative methods of refuse disposal are considered also. - Authors' Abst.

191. Sullivan, J.L.: The nature and extent of pollution by metallurgical industries in Port Kembla. (Part I.) In: Air Pollution by Metallurgical Industries, by Bell, A., and Sullivan, J.L. Division of Occupational Health, New South Wales Department of Public Health, Sidney, Australia, 1962, pp. 1:11-1:60.

This report deals with a survey of air pollution in a metallurgical town, Port Kembla, located on the east coast of Australia. Iron and copper ores are smelted and the major emissions consist of solid particles and sulfur dioxide gas. The presence of the latter is most noticeable in the wake of the plume of the stack of the copper smelter during the northeast winds which prevail in summer. In winter the prevailing winds cause industrial pollution to be blown seawards. Tests for sulfur dioxide were made by daily volumetric sampling instruments and a Thomas automatic recorder. The section of the town most severely affected consisted of a swathe of about 200 yards wide and extending to a point where habitation ceased about 0.6 miles from the 200-feet-high stack of the copper smelter. Daily readings of the gas content were not spectacular, the highest being 0.62 ppm. During a little more than three years 24-hour readings of 0.2 ppm or more were measured on 39 days. However, a different picture was obtained from the continuous recorder. This showed that high concentrations of sulfur dioxide tended to occur in episodes of a few hours each. Peaks of greater concentration than 5 ppm were recorded on numerous occasions and the maximum for the sampling period was 13.5 ppm at a point 0.45 miles from the source. Complaints of respiratory distress were made frequently and most householders had ceased to try to grow vegetables. Dust-fall rates measured as water-insoluble solids by a deposit gauge, consisting of a six-inch conical glass funnel and bottle, were high by normal standards. Average annual rates varied between 17.9 and 86.1 tons/mi.^{2}/month. In some locations within a half mile from the edge of the steel industries, the summer dust-fall rates were found to exceed 100 tons/mi.^{2}/month. At one point a mile and a half from the steel industries the monthly rate during 1960 varied between 13.6 and 43.4 tons/mi.^{2}. - APCA.

192. Zielinski, E.: Atmospheric pollution by SO_2 from an isolated chimney. Combustion 35: 16-25 (Feb.) 1964.

Ground-level measurements of SO_2 concentration were made in an 8 km area around a power station in Poland and an attempt was made to correlate these measurements with other factors governing the dispersal of gases between chimney and ground. Results are presented graphically and analyzed with respect to the probability of SO_2 pollution occurring at any particular point.

3. ATMOSPHERIC REACTION INVOLVING OXIDES OF SULFUR

193. Abel, E: On the experimental bases for the calculation of the sulfuric acid vapor pressure above the sulfuric acid-water system. J. Phys. & Coll. Chem. 52:908, 1948.

A series of thermodynamic and thermal data have been determined which would have been applicable to the relationships developed in a previous paper (J.Phys.Chem. 50:260, 1946) for the calculation of sulfuric acid vapor pressure, but which could not be fully used in that paper. They supply far more reliable numerical values for this calculation than could previously be obtained and it may therefore be desirable, in view of the importance of sulfuric acid, to examine the extent and the degree of accuracy to which the vapor pressure of sulfuric acid can now be calculated. As a supplement to the preceding paper relationships and data are shown which are derived from a series of thermodynamic and thermal values recently published. The results are critically discussed. - Author's Sum.

194. Altshuller, A.P.: Atmospheric reaction studies related to air pollution. Arch. Environ. Health 8:27-30 (Jan.) 1964.

In many respects studies of pollution of urban and adjacent rural areas by trace gases and particles cannot be separated from the study of the composition of the earth's atmosphere. Data already available indicate that carbon dioxide and sulfur dioxide produced in combustion processes may be affecting the composition of the general atmosphere. Although few detailed measurements of the geophysical levels of carbon monoxide, nitrogen oxides, methane, and other hydrocarbons are available, it is believed that production of these gases by man's activities eventually will result in increased levels throughout the atmosphere. It is essential that the atmospheric chemists obtain more detailed measurements of trace gases and particulates at remote locations on and above the earth's surface. Transfer of pollutants from urban regions to the general atmosphere makes it increasingly less likely that the values obtained will represent the natural composition of the earth's atmosphere. Author's Abst.

195. Andersen, L.B. and Johnstone, N.F.: Gas absorption and oxidation in dispersed media. A.I.Ch.E., 1:135-141 (June) 1955.

The absorption and subsequent liquid-phase reaction of oxygen was studied with 2 types of dispersion apparatus, the Venturi atomizer and the fritted-glass disperser. The systems studied in both devices included the absorption of atmospheric oxygen by catalyzed sodium sulfite solutions and the simultaneous absorption of atmospheric oxygen with nitrogen dioxide and with sulfur dioxide by water. Very large values of the liquid-film mass transfer coefficient for oxygen absorption were measured in the atomization zone of the Venturi atomizer. Over-all recovery efficiencies were less than 2.3% for nitrogen dioxide but reached as much as 22% for sulfur dioxide. Oxidation efficiencies for sodium sulfite solutions ranged up to 80% depending on the operating conditions.

The fritted-glass disperser gave recovery efficiencies of nitrogen dioxide as high as 90% from air containing 10% of the gas. The recovery efficiency decreased at low concentrations of nitrogen dioxide for both the Venturi atomizer and the fritted-glass disperser. - APCA

196. Baum, F.: Ways to prevent smog. Zbl. Biol. Aerosol Forsch, 11:106, 1963.

The 'London smog' does not only occur in the city of London but has become a problem in many regions. Systematic measurements of SO_2 in towns and industrial areas over several years revealed relationships between meteorology and the SO_2 concentration which permitted an 'SO_2 concentration forecast' in addition to the weather forecast. Such a forecast of SO_2 concentration prepares the population for the expected weather conditions and alerts them to co-operate by reducing air pollution to a minimum during dangerous smog periods. It is thought that inclusion of an SO_2 forecast in the weather forecast will be a step forward to the solution of the smog problem.

197. Bowden, S.R.: Improved lead dioxide method of assessing sulphurous pollution of the atmosphere. Internat. J. Air & Water Poll., 8:101-106 (Feb.) 1964.

The lead dioxide method for the investigation of atmospheric pollution, sometimes known as the lead peroxide candle method, measures the reaction of the sulfurous constituents of the air with a prepared surface of lead dioxide. The rate of reaction expressed in mg. SO_3/100 cm.^{2} surface/day, is influenced by the prevailing temperature, humidity, and wind velocity, and the returns include any solid sulfates which may be deposited from the air, but results depend essentially on the concentration of the SO_2 in the air. The modifications of cylinder and processing have no significant influence upon the results. A cylindrical louvered box could advantageously replace the present cubical box, but results would be raised approx. 20% to a level of that given by the cowl used before 1945, therefore it would be necessary to apply a correction. - APCA

198. Bushtueva, K.A.: Ratio of sulfur dioxide and sulfuric acid aerosol in atmospheric air, in relation to meteorological conditions. Gig. i Sanit. No. 11, pp. 11-13, 1954, in: Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U.S. Department of Commerce, Office of Technical Services, Washington, D.C., Vol. 4, pp. 193-196, (Aug.) 1960.

A direct correlation between sulfur dioxide and sulfuric acid content was found when examination was made of concentrations of sulfur dioxide and sulfuric acid aerosol sampled from the environment around Moscow under various types of weather conditions. The aerosol concentration rose greatly during calm weather. The toxic principle in several recorded smogs may be ascribed to the highly toxic sulfuric acid aerosol formed from the airborne sulfur dioxide.

199. Chaney, A.L.: Investigations to detect the atmospheric conversion of sulfur dioxide to sulfur trioxide. Am. Petrol. Inst. 38(section III):306-312, 1958.

In the gaseous state, the sulfur dioxide is only very slowly oxidized to sulfur trioxide. It has been recently suggested that in the presence of fog and particulate-matter catalysts, this oxidation may be greatly accelerated. If oxidation does occur, both sulfate and acidity of the particulate matter should increase. Because nitrate is frequently also present in significant quantities, its relationship to acidity should also be known. Techniques have been developed for testing this hypothesis in the Los Angeles area. Particulate matter was collected and weighed in two separate fractions based on particle size, and aqueous extracts of it were prepared for determination of acidity, sulfate, and nitrate. Larger particles were collected by dry impingement and the submicron size by filtration through membrane filters. Fog droplets, if present, would be in the first fraction. Simultaneous sampling for sulfur dioxide concentration was carried out by a highly sensitive and specific procedure. The sampling period was one hour, and provision was made for automatic collection of several successive samples at intervals throughout a 24-hour period.

These samples were sufficient in size for measurement of both total weight and weight of the water-soluble fraction. Chemical determinations in the microgram range were utilized for the sulfate, nitrate, and acidity measurements. The general techniques used may be extended to include the determination of a number of other constituents of particulate matter as well.

In this investigation the sulfur dioxide was usually very low in concentration and was not well correlated with sulfate levels. Other sources besides sulfur dioxide may be required to account for the sulfate levels found in the particulate matter. A large fraction of the particulate matter was found to be water soluble, particularly in the submicron fraction, and it contained acidity which could not be accounted for in terms of the sulfate and nitrate levels found.

The results were evaluated in comparison with meteorological and released data. - Author's Abst.

200. Commins, B.T.: Determination of particulate acid in town air. Analyst 88: 364-367, 1963.

Studies have been made of the acidity of urban air since regular observations of atmospheric pollution began in 1913. When particulate acid can be detected in town air, small amounts of free basic gases, ammonia and amines, are also found. Samples for the determination of H_2SO_4 in air were collected on 1-in. diam. filter papers using an airflow rate of 30 l./min. for periods up to 6 hrs. The method described has been suitable for the measurement of particulate acid in urban air. Concentrations of particulate acid at times of fog have reached levels of 678 µg. as $H_2SO_4/m.^3$ of air in the city of London. - APCA

201. Corn, M., and DeMaio, L.: Sulfate particulates: Size distribution in Pittsburgh air. Science 143:803-804 (Feb. 21) 1964.

Sulfate particles with diameters of less than 1.7 microns contribute approximately 40 percent by weight to total sulfate particulate in Pittsburgh air. The irritant nature of these particles and their small size and associated long atmospheric residence time, as well as the short half-life of sulfur dioxide in the atmosphere, suggest that particulate sulfate may be a better indicator of atmospheric pollution than sulfur dioxide. - Author's Abst.

202. Crumley, P.H., and Fletcher, A.W.: The formation of sulfur trioxide in flue gases. J. Inst. Fuel 29:322 (Aug.) 1956. Smokeless Air, Autumn, 1956.

The factors controlling the oxidation of sulfur dioxide (SO_2) to sulfur trioxide (SO_3) in the combustion of fuels containing sulfur have been investigated in a small kerosine-fired furnace. The SO_3 contents of the flue gases from the furnace were determined chemically, and were shown to depend on the sulfur content of the kerosine, the flame temperature, the amount of excess air and type of flame. The SO_3 content of the flue gases from a large oil-fired boiler has also been determined and compared with the results obtained in the small furnace. - PHEA

203. Doyle, G.J., and Davidson, N.: The kinetics of the acid-catalyzed hydrolysis of amine disulfonate ion; the third ionization constant of amine disulfonic acid. J. Am. Chem. Soc., 71:3491-3498, 1949.

The rate of the acid catalyzes hydrolysis of amine disulfonate ion, $HN(SO_3)_2{=}$, in water solution has been studied over the temperature range 25-45°. The results at constant ionic strength conform to the rate equation: $-d(HN(SO_3)_2{=})/dt + - k(H+)(HN(SO_3)_2{=})$ if the equilibrium between sulfate ion and hydrogen ion is taken into account. The uncatalyzed hydrolysis was found to have an undetectable rate compared to the rate of the acid catalyzed reaction. The variation of the rate constant with ionic strength implies that the charge product of the ions involved in the rate determining reaction is -2. The variation of the rate constant at zero ionic strength with temperature is described by the equation: K_0(ml./mole x sec.) = 2.54 x 10^{17} exp. (-23,500/RT). The relatively large value of the frequency factor (as compared with that expected on the basis of collision theory for a bimolecular reaction between uncharged molecules) is explained on the basis of a large positive entropy of formation of the activated complex, due to its electrostatic interaction with the solvent.

A mechanism involving an activated complex of amine disulfonate ion and hydronium ion may be invoked to explain these results. A hypothesis to explain the relative stability toward hydrolysis of methyl sulfamic acid as compared with phenyl sulfamic acid or amine disulfonate is advanced. In addition, the ionization function (classical ionization constant) for the equilibrium: $HN(SO_3)_2^{=} \rightleftharpoons H^+ + N(SO_3)_2^{\equiv}$ in a sodium chloride solution at an ionic strength of 1.00 at 25° was measured as 3.2 x 10^{-9}. - Author's Sum.

204. Doyle, G.J.: Self-nucleation in the sulfuric acid-water system. J. Chem. Physics 35:795-799 (Sept.) 1961.

Howard Reiss' "Vector model" was adapted to calculate the self-nucleation rate for the sulfuric acid-water system and similar systems.

A numerical calculation was carried out for the typical case of 50% relative humidity at 25°C. It was concluded that rapid self-nucleation would take place at sulfuric acid partial pressures in the range 10^{-8}-10^{-10}mm Hg. The considerable uncertainty is principally due to lack of data on the partial pressure of sulfuric acid above its aqueous solutions and on the dominant sulfuric acid-bearing species in humid atmospheres. - Author's Abst.

205. Endow, N., Doyle, G.J., and Jones, J.L.: The nature of some model photochemical aerosols. J. APCA 13:141-147 (April) 1963.

The evidence from infrared spectra of precipitated model aerosols formed by the photo-oxidation of lower olefin homologs-nitrogen oxides-sulfur dioxide mixtures at 50% relative humidity indicated that the principal constituent of the aerosol was sulfuric acid. Other analytical data - microchemical elemental analysis, spot tests, and the like - gave support to the belief that the principal constituent of these aerosols was sulfuric acid. In addition to sulfuric acid, the aerosols contained a smaller concentration of nitrite-type material. Weight loss studies of precipitated aerosols indicated either that portions of the condensed aerosol materials were volatile or that the aerosol was unstable and a decomposition product was volatile. - Author's Sum.

206. Erikson, E.: On the geochemistry of chloride and sulfate. In Lodge, J.P., Jr. (editor): Atmospheric Chemistry of Chlorine and Sulfur Compounds. Geophysical Monograph No. 3, Am. Geophysical Union, Nat. Acad. Sc. Nat. Res. Council, Washington, D. C., pp. 124-127, 1959.

The purpose of this paper is to present a picture of natural pollution caused by various geophysical and geochemical processes. Pollution caused by the presence of chlorine and sulfur in the atmosphere is discussed on a global scale.

207. Gartrell, F.E., Thomas, F.W., and Carpenter,S.B.: Transport of SO_2 in the atmosphere from a single source. In Lodge, J.P., Jr. (Editor): Atmospheric Chemistry in Chlorine and Sulfur Compounds, Geophysical Monograph No. 3, Am. Geophysical Union, Nat. Acad. Sc. Nat. Res. Council, Washington, D. C., pp. 63-67, 1959.

The Tennessee Valley Authority has in operation and in various stages of construction seven large coal-fired, steam-electric power plants. Present installed capacities of these major power plants range from 450 to 1440 megawatts. These plants have been constructed over a relatively short period of time, the first being started in 1949. At the outset, the potential air pollution from these power plants was given due consideration and control features were incorporated in the plans. Provision was made for pre- and post-operational studies to evaluate the adequacy of controls. At each of the plants, meteorological stations designed specifically for study requirements were installed when construction was started and continued to be operated. Those SO_2 autometers have been employed extensively for monitoring purposes. The 'semi-fixed' trailer mounted autometer installations have been supplemented by mobile sampling utilizing principally the Titrilog operated in a car and helicopter.

Very early in our studies we became aware of difficulties in the application of available formulas for estimating stack-gas dispersion from power plants of the size and type of the TVA plants. The gas of principal interest was SO_2. Diffusion estimates and subsequent studies were related principally to this constitutent of the stack gas. The purpose of this paper is to present a brief summary of some of our preliminary findings and to describe a full-scale diffusion study just being initiated. - Author's Introduct.

208. Gartrell, F.E., Thomas, F.W., and Carpenter, S.B.: Atmospheric oxidation of SO_2 in coal-burning power plant plumes. Am. Indust. Hyg. A. J. 24:113-120 (March-April) 1963.

Sampling equipment and procedures applicable for use in a helicopter were devised for collecting the separate SO_2 and SO_3 components in progressive plume cross sections at a large coal-burning power plant. Samples were collected during a variety of meteorological conditions with particular attention to a wide range of relative humidity. During periods of low humidity, data reveal that oxidation of SO_2 is relatively slow, increasing from 2% at one mile (12 minutes) to 3% at 6 miles (60 minutes). With moderately high humidity, oxidation was initially rapid, 22% at one mile (12 minutes), increasing to 32% at 8 miles (96 minutes). The highest total oxidation, 55%,was observed in a slight mist at 9 miles (108 minutes). - Author's Abst.

209. Gerhard, E.R., and Johnstone, H.F.: Photochemical oxidation of sulfur dioxide in air. Indust. Eng. Chem. 47:972-976 (May) 1955.

The rate of photochemical oxidation of sulfur dioxide in air was determined in the concentration range 5 to 30 p.p.m. The reaction was carried out in a Lucite cylinder in which the reaction mixture was exposed to ultraviolet light in the range from 3650 to 2950 A. The sulfuric acid drops formed as a result of the reaction were collected by a microtechnique involving impaction on an indicator film. The reaction is first order with respect to sulfur dioxide, and the rate is unaffected by the humidity, the presence or absence of salt nuclei, or by the concentration of nitrogen dioxide, in the ranges studied. The rate in artificial sunlight was in the order of 0.68% per hour and the mass median diameter of the particles was 0.19 to 0.45 microns. A few measurements in natural sunlight indicated the reaction rate to be approximately 0.1% per hour. The gas phase oxidation of sulfur dioxide of naturally polluted atmospheres in natural sunlight would not be significant in effectively reducing the visibility, since it would require approximately 100 hours of intense noon sunlight to reduce the visibility to 1 mile. Other types of oxidation, such as the liquid phase reaction in fog droplets, or a combination of gas phase and liquid phase reactions at high humidity, may be more effective in reducing the visibility. These are being investigated. - APCA

210. Gerhard, E.R., and Johnstone, H.F.: Microdetermination of sulfuric acid aerosol. Anal. Chem. 27:702-703 (May) 1955.

An analytical technique for the microdetermination of sulfuric acid aerosol was developed in which the aerosol particles were collected by a high velocity impactor on a film impregnated with thymol blue. The color change from yellow to red was measured by a photometric colorimeter attached to a low-power microscope. The method was used to determine 0.01 to 0.2 microgram of sulfuric acid. It was reliable when the quantity of acid collected was controlled. The method detects the presence of any acid aerosol, but is not sensitive to acidic gases. Alkaline gases which tend to neutralize the droplets affect the accuracy of the results. - APCA

211. Gillespie, G.R., and Johnstone, H.F.: Particle-size distribution in some hygroscopic aerosols. Chem. Eng. Progress 51:74F-80F (Feb.) 1955.

The selection and design of aerosol-removal equipment depend largely on knowledge of the size of the particle. In the present work the distribution of particle sizes of aerosols of sulfuric, phosphoric, hydrochloric, hydrobromic, and chlorosulfonic acids was measured by means of a four-stage high velocity jet impactor. The effect of the relative humidity of the air stream, the addition of foreign nuclei, the concentration of the aerosol particles and time on the size distribution was studied.

The aerosol was formed almost instantaneously by the rapid and continuous mixing of a hygroscopic vapor with a moist air stream. The particles attained equilibrium with their surroundings in a fraction of a second by taking up water vapor. If the number concentration was greater than 10^6 particles/cc., the particles continued to grow by coagulation. The particle size, which ranged between 0.1 and 6.0 μ diam., appeared to depend primarily on the method of formation of the nucleus. The size distributions followed the log-probability function from which the number of particles per unit volume of gas was obtained.

The jet impactor was shown to be readily adaptable to field work. Samples of sulfuric acid mist from the waste gases of a contact-acid plant showed the particle-size distribution to be nearly identical with distributions made from sulfur trioxide and water vapor under similar conditions in the laboratory. - Author's Abst.

212. Glebova, L.F.: Maximum allowable concentration for hydrogen sulfide in the atmosphere. Gigiena i Sanit. No. 4:19-21, 1950.

Analysis of air samples taken at a distance of 1 km. from a viscose plant revealed the following contamination of the air (average concentrations given in mg./m.^{3}): H_2S 0.05 and CS_2 0.075. In 1947-8, 90 infants, ranging in age from 1 mo. to 3 yr., who stayed at the plant nurseries 800 m. and 2 km. away from the plant were examined. Several of the nursing infants were found to be in a poor state of nutrition, asthenic and anemic. They showed gastrointestinal disorders, increased susceptibility to infectious diseases and retardation of growth, i.e., development of teeth, walking, etc., which are illustrated by 2 case reports. It was established that the mothers, when coming over to the nursery from their work in the spinning room of the plant, nursed the infants without changing their clothes. Immediately or 30-40 min. after nursing, the infants vomited, which also happened when the mothers wore coats over their work clothes. The connection between the mothers' exposure and the conditions observed in the infants was demonstrated when the mothers were transferred to another section of the plant where no such exposure was present. The vomiting of the infants disappeared, and the conditions of the children improved. Since there was an obvious relationship between the children's contact with the contaminated work clothes of the mothers and the symptoms seen in them, analyses of the air under these clothes were carried out, controls being provided by taking similar air samples from women working in plant sections other than the spinning room. The results were negative for CS_2 but showed the presence of H_2S at 0.028-0.055 mg./m.^{3}, i.e., at the level of the present MAC for H_2S. All control results were negative. It was surmised that the described symptoms were due to the cumulative effect of H_2S on the infants who had not yet developed the proper resistance to the substance. The fact that very young infants are more susceptible to H_2S and that disorders of the gastrointestinal tract like those described here severly disturb their growth and development should lead to a revision of the MAC for H_2S. - KB

213. Goetz, A.: Nature of synergistic action of aerosols. Internat. J. Air & Water Poll. 4:168-184 (Sept.) 1961.

The paper gives a theoretical treatment of the kinetic aspects of free gas molecules and their interaction with the surface of airborne particles. It aims at a physical interpretation of aerosol synergism in general, and in particular of the intensification of toxic (or irritant) gas traces by certain aerosol types.

Aerosols can act as intensifiers of the physiological reaction if their substance has a sorptive affinity for the toxic gas component large enough to produce an accumulation on the particle surface, but smaller than the affinity of the tissue surface which they contact in order to effect a transfer of the molecules thereon. If the particle affinity substantially exceeds that of the tissue, an attenuation of the effect should occur.

The theoretical functions derived from these assumptions are applied qualitatively to the data reported by LaBelle, et al. (1955) for 27 gas-aerosol combinations, and quantitatively to those by Amdur (1960) on the effect of NaCl aerosols in the presence of HCHO, and good agreement is obtained.

Within the margin of experimental error the data can be described quite accurately by the theoretical functions and no conflict is apparent. - Author's Abst.

214. Goldsmith, J.R.: Some implications of ambient air quality standards. Arch. Environ. Health 4:151-167 (Feb.) 1962.

In 1959 the California State Department of Public Health was directed to set standards for the quality of the air of the State and also to set maximum allowable standards of emissions of exhaust contaminants from motor vehicles. The standards were to be based on the health factors, including irritation to the senses and death of human beings, as well as damage to vegetation and interference with visibility. A considerable body of knowledge in relation to these factors, plus the existence of standards in other fields such as food, milk, water and industrial hygiene, provided a background for the agency to develop the air quality standards. Part of these standards is a tabulation of alert values for carbon monoxide, nitrogen oxides, sulfur oxides and ozone. Three stages of alert are established: (1) a warning alert of the close approach to the maximum allowable concentration; (2) an alert indicating a health menace exists in a preliminary stage; and, (3) an alert stating a dangerous health menace exists.

The standards, which differ from the alert values, have been established for oxidant, sulfur dioxide, carbon monoxide and particulates. For example, the adverse level for sulfur dioxide is 1 ppm. for 1 hour or 0.3 ppm. for 8 hours (plant damage); the serious level is 5 ppm. for 1 hour (bronchoconstriction in human subjects) and the emergency level is 10 ppm. for 1 hour (severe distress in human subjects). It is noted that sufficient data for setting standards for carcinogens, ozone, nitrogen dioxide, lead, and ethylene were not found. The value of employing epidemiological and physiological factors in addition to toxicology is stressed. The present standards are by no means in final form. A continuing study and evaluation of ozone, lead, ethylene, nitrogen dioxide, fluorides, hydrogen sulfide and other compounds is currently under way. - PHEA

215. Haagen-Smit, A.J.: Atmospheric reactions of air pollutants. Indust. Eng. & Chem. 48:65A-66A, 68A (Dec.) 1956.

A chemical analysis of Los Angeles air shows that the air has a strong oxidizing character, contrary to what might be expected if sulfur dioxide were the main pollutant. This oxidizing effect is due not to the presence of free halogens or heavy metal oxides, but chiefly to a high level of ozone, plus smaller amounts of organic peroxides and oxides of nitrogen. Eye irritation and plant damage occur with high oxidant values. Plant damage was chosen to test the hypothesis that the auto-oxidation products of organic compounds, chiefly of petroleum origin, are responsible for smog effects. It was established that the Los Angeles atmosphere has high ozone levels during smog periods, and that damage to plants by fumigation with ozone and gasoline was actually a second phase in the production of smog. The first is the photochemical oxidation of hydrocarbons in the presence of nitrogen dioxide, whereby ozone is formed as a by-product. This reaction is not limited to hydrocarbons. Good ozone formers are diolefins, olefins, aldehydes, and alcohols. Hydrocarbons and their partial oxidation products are found in the exhaust gases of automobiles. Automobiles are the largest contributors to the hydrocarbon problem and to the emission of oxides of nitrogen. These are formed,during fuel combustion, through nitrogen fixation of the air. Total quantity of nitrogen oxides released by all fuel burning is estimated at 1200 tons/day; 800 are attributed to the automobile. Limits of emission are set for industry as well as for individuals in effect, rationing of the air. Pollution is best controlled at the source, and industry has undertaken this task on a large scale. Density of population and industry is increasing at a rapid rate. Dust collection, recovery of sulfur oxides and oxides of nitrogen, greater efficiency of combustion processes, and many other aspects of air pollution are in need of thorough investigation. - APCA

216. Haldane, J.S.: Atmospheric pollution and fogs. British Med. J. 1:366 (Feb.) 1931.

This report and discussion of the Meuse Valley catastrophe of December 1930 states in part: "The sulfuric acid is present in the air as minute liquid droplets of dilute sulfuric acid, condensed on solid nuclei, while the sulfurous acid is present as a gas... These particles are evaporated to a much greater extent inside buildings, though acid nuclei still remain and make the air inside us as irritating as that outside. Many Liege victims had never been outdoors at all." - BAAP

217. Helwig, H.L., and Gordon, C.L.: Colorimetric method for continuous recording analysis of atmospheric sulfur dioxide. Anal. Chem. 30:1810-1814 (Nov.) 1958.

Sulfur dioxide in the atmosphere can be determined continuously with automatic sampling and recording apparatus. The reaction of sulfurous acid with pararosaniline hydrochloride and formaldehyde produces a red-violet color which is measured colorimetrically. At pH 1.5 this reagent is stable and exhibits good resistance to interferences at concentrations found in the atmosphere. This method is considered flexible and useful for air pollution work. By varying reagent and sample flow rates, concentrations in the order of pphm. can be obtained in areas of low concentrations, and higher concentrations can also be recorded by reversing the ratios of sample and reagent flow rates. In the system set up to utilize this method, the range of concentrations expected was from 0 to 5 ppm. of sulfur dioxide. - APCA

218. Hettche, H.O.: Study of comparing the content of soot and carbon dioxide compounds in the air of the Federal Republic and other countries. Staub 23:136-140 (March) 1963.

Hydrocarbons and carbon monoxide at present hardly represent a hazard if small groups, such as for example, the neighbors of treatment plants or motor drivers working continuously in large towns, are ignored. The situation is different with respect to the burden placed on large sections of the population by soot and its two adsorbates-sulfuric acid and benzpyrene. In larger towns, therefore, an attempt must be made to employ only low-soot combustion of low-sulfur fuel. - English Sum.

219. Ishizaka, Nagano, Nishizaki, and Okabe: Microamounts of sulfurous gas with the aid of a reaction at the surface of drops. Rev. Assoc. Prevent. Pollution Atmospherique (APPA) (Paris) 2:292-299 (July-Sept.) 1960.

The authors have developed a system of measurement, and given equations for the reactions, for estimating microamounts (1 to 50 ppm.) of SO_2 in the atmosphere. The equations employed are based on those of Langmuir for the reaction of adsorption and diffusion of a gas analyzed on the surface of a drop of liquid. The probability of error is in the range of 10% without need for any temperature corrections, assuming that the temperature range is 18-24°C. The method employs the de-colorization by H_2SO_4 of the purple-blue color produced as the result of the contact of iodine with starch. By letting the reaction liquid drop continuously, a continuing measure can be obtained of the average value of SO_2 in the atmosphere. - APCA

220. Johannesson, J.K.: A note on the determination of low concentrations of sulfate in rain and other waters. New Zealand J. Sc. (Wellington) 1:423-424 (Sept.) 1958.

Previously the methods for determination of low concentrations of sulfate in rain and other waters were difficult and of low precision. The author presents a new and direct method which both is rapid and shows great precision for sulfate in water where the concentrations are in the range of 0 to 10 ppm. The principle of the method is that when a solution containing only sulfuric and hydrochloric acids, such as that obtained by treatment of a natural water with an ion exchange resin of the cation type, is treated with mercuric oxide, very poorly-conducting mercuric chloride and conducting mercuric sulfate are formed. The sulfate is then determined by measuring the conductivity of the resulting solution, which is almost entirely due to the sulfate. Details of the method are given, as well as the graphs showing the standard curve for sulfate and the correction curve for chloride content. - APCA

221. Johnstone, H.F.: Properties and behavior of air contaminants. Indust. Med. & Surg. 19:107-115, 1950.

S gases and vapors, N and halogen compounds, CO, CO_2, exhaust gases, peroxides and O_3 are discussed as to their physiological effects, sources, prevalence and means of removal. Aerosol contaminants are discussed as to their physical properties, viz., effect on visibility, deposition, coagulation, evaporation, Brownian diffusion, electrical properties, dispersion and physiological effects, and sources. The gases and vapors present in contaminated air are of interest mainly from their chemical behavior, e.g., conversion to obnoxious compounds by reaction with other contaminants, or with O_2 in sunlight, whereas the physical properties of aerosols of suspended particulates, e.g., effective particle size, are of most importance.-KB

222. Johnstone, H.F., and Coughanowr, D.R.: Absorption of sulfur dioxide from air. Oxidation in drop-containing catalysts. Indust. Eng. Chem. 50:1169-1172 (Aug.) 1958.

Droplets of sulfuric acid formed by absorption of sulfur dioxide and oxygen from air by fog droplets nucleated by oxidation catalysts may be important in air pollution. Rates of acid formation were measured when dilute drops of manganese, iron, copper, and nickel sulfates were exposed to air containing sulfur dioxide. The reaction between solutions of sulfur dioxide and oxygen in the presence of manganese sulfate is zero order with respect to both reactants and the rate is proportional to the square of catalyst concentration; it is retarded by small concentrations of acid. A mathematical analysis was developed for the steady-state absorption of sulfur dioxide by drops of catalyst solutions. The calculated rate of conversion of sulfur dioxide in a natural fog is about 500 times the rate of photochemical oxidation of sulfur dioxide in air in intense sunlight. - PHEA

223. Johnstone, H.F., and DevJain, K.: Sulfur dioxide sensitized photochemical oxidation of hydrocarbons. Science 131:1523-1524 (May 20) 1960.

Near-ultraviolet sunlight is absorbed by sulfur dioxide to produce electronically excited molecules which react with n-butane in presence of wet or dry air to produce an aerosol and eventually a liquid precipitate. The product is a heavily oxidized sulfur-containing organic strong acid. The possible role of these reactions in photochemical air pollution is discussed. The studies were made with a view toward determining the role of sulfur dioxide in air pollution. - Authors' Abst.

224. Johnstone, H.F., and Moll, A.J.: Air pollution by formation of sulfuric acid in fogs. Indust. Eng. Chem. 52:861-863 (Oct.) 1960.

Formation of sulfuric acid from sulfur dioxide in fog droplets containing dissolved oxidation catalysts is important in air pollution. Rates of acid formation were measured in fogs formed under controlled conditions in air containing nuclei and 4 to 500 ppm of SO_2, corresponding to concentrations in stack gases from the combustion of sulfur-bearing fuels after dilution 10 to 1000 times. In expansion fogs with manganese sulfate nuclei, concentrations of H_2SO_4 between 0.1 and 2 mg. per cubic meter were formed in less than 5 minutes, depending on the sulfur dioxide concentrations and the time of exposure of the fog. Other manganese salts produced similar concentrations of acid. Fogs formed with ferrous sulfate nuclei and those with mixtures of manganese sulfate and sodium chloride as nuclei produced acid at slower rates than fogs with manganese sulfate nuclei only. The highest rate of acid formation was in fogs with manganese sulfate nuclei at relative humidities just below 100%. In these fogs the rate of acid formation was approximately proportional to the concentration of sulfur dioxide between 4 and 500 ppm. - PHEA

225. Junge, C.E., and Ryan, T.G.: Study of the sulfur dioxide oxidation in solution and its role in atmospheric chemistry. Quart. J. Royal Meteorol. Soc. 84:46-55 (Jan.) 1958.

The mechanism of sulfur dioxide oxidation in diluted catalytic solutions was studied. It was found that the oxidation stops after a certain pH value is reached. In the same catalytic solutions, the maximum possible sulfate ion formation is a linear function of the SO_2 partial pressure in the air. The mechanism of sulfate formation can account for observed sulfate concentrations in rain, fog, and smog only if some neutralizing cations in the aerosols or traces of ammonia in the air are present. It is shown that in the latter case the system SO_2 - NH_3 - catalytic solution can explain the main features of sulfate formation in our atmosphere. - APCA

226. Kitamura, K.: Formation of fog from the meteorological point of view. Denryoku (Tokyo) 46:6-10 (March) 1962.

The mechanism of, and the topographic factors involved in, the formation of various types of fog are discussed. A study was made of the average number of foggy days, in the yrs. 1921-50, at several locations where various types of fog occurred. The relation between water content of fog and the range of visibility are shown on a graph. Other topics discussed are fog droplet size and distribution, condensation nuclei in city fog, inversion layering, night heat-loss from the earth, and cold fronts producing rain and fog. Graphs showing the amount of deposited dust (ton/km.^{2}/month)from 1935-55 in Osaka indicate a min. in the period immediately after the end of the war,due to the industrial decline. Also shown are the number of foggy days from 1940-60. The author notes that the 2 curves have similar aspects but he can give no explanation for the fact that the graph pattern of the number of foggy days appears to lag 3 yrs. behind that of the amount of deposited dust. The max. amount of deposited dust was 12 tons/km.^{2}/month in 1935, about 13 tons in 1955, and a min. of 2.5 tons in 1946. The max. number of foggy days was 140 in 1940, 110 in 1954, and a min. of about 25 in 1949. - APCA

227. Koenuma, K.: The stability and variation of fog particles. Geophys. Mag. (Tokyo) 23:373-377, 1952.

As is well known, condensation in the atmosphere takes place on some hygroscopic substances which suspend in the atmosphere in abundant number and absorb the water vapor even below 100% of relative humidity. These hygroscopic substances may be considered to be NaCl, $MgCl_2$, SO_3,and etc., though details are not yet known. Such being the case, fog particles may be thought to be aqueous solutions of these salts, whose saturation vapor pressure at a given temperature is lower than that of pure water and depends on the concentration of the solution. It has been frequently observed that relative humidity in the foggy air mass is below 100%. This may be explained by considering that fog particles are aqueous solutions of some salts.

In this paper, considering fog particles to be aqueous solutions of some salts, we intend to discuss the stability and the variation of magnitude of a fog particle. For the complete discussion of this problem, the electric charge of fog particle must naturally be considered, but it may be left for the future. - Author's Introduct.

228. Kopczynski, S.L., and Altshuller, A.P.: Photochemical reactions of hydrocarbons with sulfur dioxide. Internat. J. Air & Water Poll. 6:133-135 (March-April) 1962.

Some years ago Dainton and Ivin (1950) found that at high concentrations sulfur dioxide reacts appreciably with n-butane and isobutane using radiation in the 2400 to 3340 Å region. Sulfinic acids are formed. More recently Johnstone and DevJain (1960) reported that irradiated mixtures containing 20 to 50 mm each of sulfur dioxide and n-butane react in the presence of air to form heavy aerosols. A yellow to colorless liquid film was observed on the walls of the flask, which was believed to be a mixture of highly oxidized strong organic acids containing sulfur. Johnstone and DevJain suggested that the photochemical reactions between paraffinic hydrocarbons and sulfur dioxide may contribute significantly to air pollution,particularly formation of aerosols. The concentrations of reactants used in both of these previous investigations were four to five orders of magnitude higher, however, than those existing in ambient polluted atmospheres. The results of the earlier studies were first verified, and then the studies were extended to lower concentrations. Most of the work was done with mixtures of n-butane and isobutane-sulfur dioxide; however, mixtures of sulfur dioxide with neopentane, ethylene, 1-pentene and 3-methyl-1-butene also were investigated. - Authors' Abst.

229. Lodge, J.P., Jr., Ferguson, J., and Havlik, B.R.: Analysis of micron-sized particles. Determination of sulfuric acid aerosol. Anal. Chem. 32:1206-1207 (Aug.) 1960.

In air pollution research, as well as in other scientific fields, there is a need for a reliable technique for determining loadings and the size spectra of sulfuric acid aerosols. A combination of the methods by Gerhard and Johnstone, and by Lodge and Franzio was developed by the authors, yielding a technique which simultaneously detects hydrogen and sulfate ions.

230. Mader, P.P., Hamming, W.J., and Bellin, A.: Determination of small amounts of sulfuric acid in the atmosphere. Anal. Chem. 22:1181-1183, 1950.

A method has been developed for determining small concentrations of sulfuric acid mist in the atmosphere. It employs specially prepared filter papers for the removal of this aerosol from the air stream and determines the acidity by titration. With the help of this method it is possible to measure variations of the amount of free sulfuric acid in the air on an hourly basis. - Authors' Abst.

231. Meethan, A.R.: Natural removal of atmospheric pollution during fog. Royal Meteorol. Soc. Quart. J. 80:96-99 (Jan.) 1954.

The average life of smoke particles and SO_2 molecules over land in Britain are calculated as: smoke 28 hr., SO_2, 8 3/4 hr. In the London fog of December 1952 observed concentrations (2.2 mg/m^3 smoke, 2.1 mg/m^3 SO_2) were much less than if all emitted had accumulated, and average life is calculated as: smoke 13 hr., SO_2 6 hr. The causes of shorter life in fog are discussed and found to be complex. - PHEA

232. Minami, S., et al.: A survey on air pollution in Tokyo district observed through the concentration of SO_2 in the atmospheric air. J. Science Labor (Japan) 31:508 (Aug.) 1955.

Air pollution in terms of urban community health has become one of the important public health problems in Japan. An investigation was carried out to clarify the present condition of air pollution in the city of Tokyo during the third week of January, 1955. As an indicator of degree of air pollution, the concentration of SO_2 in the atmospheric air was employed. A modified method of Thomas' was used for the determination of SO_2 concentration. The following results were obtained: (1) the weather was seasonal during the period of the investigation; (2) concentration of SO_2 was higher at 3 P.M. than other parts of the day; (3) the direction of the wind was highly associated with the degree of air pollution. When the velocity of wind was higher, the concentration of SO_2 was found low; (4) observing the correlation between potential temperature difference and SO_2 concentration, the degree of stability of atmosphere was associated with the concentration of SO_2. - APCA

233. Napier, D.H., and Stone, M.H.: Catalytic oxidation of sulfur dioxide at low concentrations. J. Appl. Chem. 8:781-786 (Dec.) 1958.

A suggested process for removing sulfur oxides from boiler flue gases requires as a first stage the oxidation of sulfur dioxide to sulfur trioxide, followed by the removal of sulfur trioxide as ammonium sulfate or sulfuric acid. Only work on the first stage is reported in this paper. As little attention has been given previously to the catalytic oxidation of sulfur dioxide in flue gases, bench-scale experiments with simple apparatus were made to examine the reaction under these conditions.

Four vanadium pentoxide catalysts of differing composition were compared, and the best was then used in a brief study of the following variables: contact time, sulfur dioxide concentration, and oxygen concentration.

The results suggest that it might be technically feasible to oxidize the sulfur dioxide in flue gases, and that normal variations in flue gas composition would have little effect on the reaction. - PHEA

234. Neuberger, H.: Condensation nuclei. Their significance in atmospheric pollution. Mech. Eng. 70:221-225, 1948.

There are 2 general types of aerosols in the atmosphere, the so-called "neutral" particles, commonly known as dust, and condensation nuclei which are made up of hygroscopic substances. The former range in size from ca. 3×10^{-5} - 10^{-3} cm. and larger; they are of more nuisance but are less harmful than the condensation nuclei. These latter consist of Cl^- salts, H_2SO_4, P compounds, N oxides and HNO_3, range in size from 10^{-7} - 10^{-5} cm. and weigh 10^{-14} - 10^{-18}g. The natural sources are volcanic eruptions, spray from ocean surfaces, combustion products from forest fires and exhalations from living or decaying vegetation and bacteria. Artificial sources include industrial furnaces and processes of various kinds, transportation exhausts and domestic fires. Due to their hygroscopic character, these nuclei grow in size as the relative humidity increases above 70%, and haze and fog are formed. The greater the concentration of these droplets, the faster they grow and the greater the density of the cloud they form. Not many nuclei are needed to produce a dense cloud, ca. 300-500 nuclei/cc. In a unit volume of fairly clean air, the nuclei are ca. 50 times as numerous as the dust particles. In industrial cities, the dust particles represent only a fraction of 1% of the total amount of suspension found in the air. In the free atmosphere, the nuclei exceed dust particles by a factor of several thousand,due to greater amount of sedimentation of the larger dust particles, and greater ease of wind transport for the nuclei. Inconsistent results have been reported on the effect of precipitation on dust and nuclei. Exposed surfaces are corroded by nuclei containing Cl_2, S and NH_3. The biological effects of the nuclei on human beings are discussed. Though reduction of sunlight, particularly UV light, by dust and nuclei occurs, this is not thought to be too serious since most city residents do not spend much time outdoors anyway and, further, sunlight has been found to cause a high incidence of skin cancer among outdoor workers. Very little factual data are available on the effect of the nuclei on the human respiratory system. Studies of the retention of condensation nuclei in the respiratory tract have shown that even if 150,000 billion nuclei/year were retained, the body's weight increase would be only 15 mg./yr. However, the acrid sensation felt in the throat from H_2SO_4 nuclei is quite unpleasant and it is also conjectured that the inhaled ions or electrically charged nuclei may be responsible for restlessness and psychological depression. Dust is considered to be of less biological significance,due to its fewer numbers and greater ease of nasal filtration. - KB

235. Orr, C., Jr., Hurd, F.K., and Corbett, W.J.: Aerosol size and relative humidity. J. Colloid Sc. 13:472-482 (Oct.) 1958.

The behavior of aerosol particles and droplets under varying humidities is of practical concern in studies of air pollution, visibility, microwave energy propagation, aircraft icing, fog formation, artificial weather modification, and cloud physics in general. The purpose of this article is to describe the behavior of solid (at low humidities) hygroscopic aerosol particles over a wide range of humidities and to show that results in reasonable agreement with experimental ones may be estimated, although extension of data into regions of supersaturation are required. Particle and droplet size and size change were determined from mobility measurements,i.e., the movement of the particles under imposed electric fields. Refinements in the method of interpretation of the mobility data allowed specific size information to be obtained,in contrast to earlier work which yielded only average values for the entire size distribution. Crystal or low humidity particle was confirmed with electron photomicrographs. The results in every case checked the predicted curves. Typical correspondence of calculated and experimental data is shown by curves. - APCA

236. Parkison, R.V.: The absorption of sulfur dioxide from gases of low concentration. Tappi 39:522-527 (July) 1956.

This report describes a study of the absorption of sulfur dioxide from gases containing low concentrations in the range of 0.5 to 1.5% of sulfur dioxide. This is the range of concentration encountered in flue gases from recovery furnaces burning spent pulping liquors. The results are expressed in terms of over-all coefficients that would be an adequate design criterion. The results are discussed in terms of existing absorption theories. - APCA

237. Phair, J.J., Shephard, R.J., Carey, G.C.R., and Thomson, M.L.: The estimation of gaseous acid in domestic premises. Brit. J. Indust. Med. 15:283-292 (Oct.) 1958.

A description is given of a small sequence sampler that gives 6-hourly readings of gaseous acid concentration in domestic premises. Factors affecting the rate of sampling and evaporation of absorbent solution are evaluated. Evaporation is an important problem with the original model and methods of minimizing water loss have been incorporated in later designs of the apparatus. Gaseous acid measurements largely reflect the amount of SO_2 in a suburban atmosphere and an efficiency of 95% can be obtained with a single-stage sampling. Ammonia and hydrochloric acid vapor are also absorbed although these are present in lesser and approx. equal amounts. Sulfur trioxide is not absorbed to any significant extent, but this is a minor constituent of suburban atmospheres. The variation between different sampling units in the same room is considerable in the presence of dry gaseous SO_3, and even under normal room conditions the 95% confidence limits of observations made from a single point are ± 0.0024 ppm. Differences between different parts of a large building are even greater. Indoor measurements show a general tendency to follow outdoor readings with a lag of up to 2 hrs.; however, the indoor concentrations of gaseous acid are on the average much lower, and do not show the sharp peaks seen at outside locations. The relationship between gaseous acid levels in different parts of the city is not constant since in each area the industrial output is supplemented by a seasonally varying domestic heating load. The relationship between gaseous acid and particulate contaminants also varies in different parts of the town, perhaps on account of differing amounts of alkaline pollutants in the atmosphere.- APCA

238. Prager, M.J., Stephens, E.R., and Scott, W.E.: Aerosol formation from gaseous air pollutants. Indust. Eng. Chem. 52:521-524 (June) 1960.

Earlier research at relatively high concentrations has yielded condensed products of ozone-olefins or photochemical nitrogen dioxide-olefin reactions. These have been held responsible for reduced visibilities during smog attacks in the Los Angeles area. In this study aerosols have been formed in such reactions at ppm. concentrations only with highly substituted or cyclic olefins or diolefins. When sulfur dioxide is added to irradiated nitrogen dioxide-olefin systems, aerosols were obtained with all types of olefins. The hydrocarbon and oxide of nitrogen concentrations found in the Los Angeles area are insufficient to cause the reduced visibility. Reactions between olefins, oxides of nitrogen, and sulfur dioxide could conceivably account for the aerosol, but whether they do remains to be established.- APCA

239. Pritchett, P.W.: The catalyzed reaction of oxygen with sulfurous acid and its effect on the absorption of oxygen and sulfur dioxide into water. Dissertation Abstr. 21:2652, 1961.

The absorption of sulfur dioxide and oxygen into a manganese sulfate solution was investigated to observe the influence of the liquid phase oxidation reaction on the rates of absorption. This particular system is of potential importance in controlling air pollution. The investigation was carried out in 2 phases: a study of the kinetics of the liquid phase reaction and a study of the absorption with simultaneous reaction. The absorption experiment revealed the role of oxygen in the kinetics more clearly than was possible from the study of liquid phase kinetics alone. New theoretical developments include an exact analytic solution for absorption rates with simultaneous zero-order reaction and a general approxn. method based on the steady-state solution for absorption rates with simultaneous reaction.- APCA

240. Rasmussen, R.E.H., Rallis, T., and Rydal, J.: On dissipation of fog. Progress Rept. Lab. Tech. Physics. Univ. Denmark. Ingenioren (Copenhagen) 3:124-142 (Dec.) 1959.

The most important previous works, both theoretical and experimental, on the problem of the dissipation of fog (or dust) in the atmosphere, are reviewed with special reference to the importance of fog or dust to air traffic. Previously, some preliminary experiments were carried out using an acoustic air-jet generator with supersonic velocity. At an English airport during the war, powerful centrifugal pumps supplied fuel to rows of burners running parallel with the runways. At another airport air-raid alarm-sirens were used in an attempt to coagulate the aerosol particles by audible sound waves. In this case, the sirens wore out in a short time owing to the high rotational speed. Later some laboratory and field experiments were made with non-rotating sirens, plus a fuel oil atomizer to help circulate the air and to supply nuclei for condensation. Other attempts have been made using surface-active coagulating substances, hygroscopic materials such as CaCl, and electrostatic precipitators. The current experiments were begun with studies of the measurement of ultra-sound fields, with experiments on the settling of solid particles suspended in air, and with attempts to generate an artificial fog. Some of the theory, and the resulting equations, are given. Following the generation of an artificial fog, a series of experiments were unsuccessful in dissipating the fog when the ultrasonic sound was used. Resumption of the experiments using ordinary sirens of the air-alarm type produced a considerable effect on settling the fog. Additional experiments using a modified cyclone indicated good consistency with the outlined theory. Possible application of this latter method to a runway at the Copenhagen airport is discussed briefly. - APCA

241. Renzetti, N.A., and Doyle, G.J.: Photochemical aerosol formation in sulfur dioxide-hydrocarbon systems. Internat. J. Air Pollution 2:327-345 (June) 1960.

We have conducted a series of photochemical experiments in a 50-l stirred-flow reactor to study aerosol formation from different hydrocarbons in the presence of nitrogen oxides and sulfur dioxide.

Irradiation by simulated sunlight of trace concentrations (p.p.m.) of the reactants, in some cases, yielded particles in the size regime 0.1-0.3 μ diameter, which by scattering of light are important to visibility in the atmosphere. A large number of experiments with 3 p.p.m. of various hydrocarbons, 1 p.p.m. nitrogen oxides, and 0.1 to 0.5 p.p.m. SO_2 indicated that the olefinic hydrocarbons were the only important aerosol formers in contrast to the paraffinic and aromatic hydrocarbons. It was observed that the photolysis of sulfur dioxide proceeds at the rate of 0.4 percent per minute, which is considerably above that observed by Johnstone and Gerhard (1955). The high sulfate content of the particulate matter and low gaseous sulfur dioxide concentrations observed in the Los Angeles smog are consistent with the findings of this laboratory program. - Authors' Abst.

242. Ries, E.D., and Clark, E.E.: Analysis of sulfur dioxide in the presence of excess air. Indust. Eng. Chem. 18:747, 1926.

The literature on the determination of sulfur dioxide in the presence of excess air is involved and contradictory. Since the analysis is very important for control work in commercial processes, such as contact sulfuric acid and paper manufacture, the problem has been attacked by a large number of investigators; but most of the methods developed have necessitated sharp control of the concentrations involved and other similar restrictions.

During an investigation on the oxidation of sulfur dioxide, it was necessary to analyze with precision small amounts of low-percentage SO_2-in-air mixtures. In view of the many contradictory statements in the literature, it was decided to find out whether any of the various methods suggested would work with the desired accuracy. There was no attempt to make the investigation complete, and a method was discarded as soon as it was found to be unreliable. - Authors' Abst.

243. Ritchie, A.W., and Langrishe, J.: Smoke abatement. J. Soc. Chem. Indust. 54:979-982, 1935.

Mr. Allen, Chief Sanitary Inspector, Edinburgh, discussed the causes of smoke, the measures taken for the reduction of smoke, and the investigation into atmospheric pollution. The data from the deposit gauges at 3 places in the city are given for 1929-34. The values ranged from 13.67-16.67 at Leith Links, 12.80-15.09 at Bruntsfield House and 19.78-27.51 tons/sq. mi./mo. at Princes St. Gardens. The Owens automatic air filter showed that pollution is at a minimum at 3 a.m., increases to a maximum at 9-10 a.m., decreases again 'till 3 p.m. and then reaches a secondary maximum at 7 p.m. Pollution is about 31% less in summer than in winter. A comparison of the results obtained on weekdays and Sundays indicate that 4/5 of the pollution in the City is domestic and 1/5 industry. December has the highest pollution and July the lowest. Measurements of S pollution by bubbling the air through H_2O_2 solution and subsequent titration showed <0.1 ppm SO_2 in Nov. and Dec.

Lt. Col. Langrishe reported that from the statistical evidence the number of deaths from pulmonary and heart diseases increases in direct proportion to the intensity and duration of smoke-fogs. As cited by Baillie Brownhill Smith, in Nov. and Dec. 1909, Glasgow had 3 periods of dense smoke-fog. Deaths from respiratory diseases during the week preceding the fog totalled 75; during the week of the 1st fog period they amounted to 138 and in the ensuing week they rose to 233. Over the whole period of bad fogs the respiratory death rate rose from 2.1-13.9/1000, while in 7 other towns, fog-free at this time, the rates rose from 1.6-4.8/1000. This difference in Glasgow had accounted for 1000 actual deaths. The effects of obstruction of sunlight are distinct. Manchester on a still day receives 55% of the daylight received in Timperley, only 6 miles S, and on foggy days it receives but 5%. Even less UV light with its less penetrating powers is received. The loss of visibility is also hazardous. A 25% increase in industrial accidents is estimated to be caused by reduction of visibility indoors, and the compensatory use of artificial lighting is estimated to cut output by 11%. The stunting effect of loss of solar radiation on human beings, the psychological ill-effects and the action of smoke on vegetation are mentioned. - KB

244. Schade, C.: Sulfur dioxide in Pittsburgh air. J. Indust. Hyg. & Toxicol. 15:150 (May) 1933.

This paper presents the results of a series of sulfur dioxide determinations made of the air from 1927 to 1932 in Pittsburgh as a part of a broad air pollution investigation. Three sampling stations of three heights, 40 to 163 feet, were used. It is reported that on days that the fog cleared by afternoon, there was a decrease of sulfur dioxide. On days that fog persisted, the sulfur dioxide concentrations were found increased. In all instances the levels of sulfur dioxide were low. The report concludes that the amount of sulfur dioxide present in Pittsburgh air is too small to be a cause of concern from a hygienic standpoint. - BAAP

245. Schuck, E.A., and Doyle, G.J.: Photooxidation of Hydrocarbons in Mixtures Containing Oxides of Nitrogen and Sulfur Dioxide. Air Pollution Foundation, San Marino, Calif., 1959, Report No. 29.

Contents: Introduction. Experimental techniques. Results and discussions: Photooxidation of hydrocarbons. Products of the photooxidation of hydrocarbons. Ozone values during photooxidation of organic compounds. Mechanism of the photooxidation of isobutylene in air. Eye irritation resulting from photooxidation of hydrocarbons. Particulate matter and its relation to the photooxidation of mixtures containing sulfur dioxide, hydrocarbons, and oxides of nitrogen. Correlation with previous data. Appendices. Note: This is the 3rd technical report published by the Air Pollution Foundation on the work performed in the smog chamber at Stanford Research Inst. The previous reports dealt with the reaction of dilute automobile exhaust in air. The present report presents data on the photochemical reaction between oxides of nitrogen and various pure hydrocarbons between oxides of nitrogen and various pure hydrocarbons found in exhaust gases, and between oxides of nitrogen and selected solvents. - APCA

246. Shirai, T., Hamada, S., Takahashi, H., Ozawa, T., Ohmuro, T., and Kawakami, T.: Photooxidation of sulfur dioxide in air. J. Chem. Soc. of Japan. Indust. Chem. Section 65:1906-1911 (Dec.) 1962.

Distribution of sulfur dioxide and the degree of oxidation of sulfur in the air were studied at the Zaoh Mining Factory in Yamagata Prefecture. The ratio of sulfur dioxide to total sulfur oxide at Zaoh was found to be smaller than that found at Keihin (Tokyo-Yokohama) industrial area. The relative intensities of solar radiation at Tokyo and at Zaoh were similar over the range from 400 mμ to 320 mμ, while the decrement of relative intensity of the light shorter than 320 mμ at Tokyo was larger than at Zaoh. The photooxidation of sulfur dioxide in the air (which was studied in the laboratory with mercury lamp irradiation) was found to be a first order reaction with respect to sulfur dioxide and to be accelerated by moisture. Photooxidation rate of sulfur dioxide at Zaoh was calculated from variation rate of ratios of concentration to be 1.95×10^{-3} sec^{-1}. The overall quantum yield of photooxidation reaction at Zaoh was calculated to be 1.73. This value was remarkably large compared with the quantum yield of $10^{-2} x\ 10^{-3}$ at cities. The causes of the difference were considered to be attributable to the differences of the effects of wave lengths and of the moisture content of the air. - APCA

247. Stern, A.C.: Atmospheric pollution due to smoke. Heating & Ventilating 42:67 (May) 1945.

"A droplet of sulfuric acid, the form in which sulfur trioxide would exist in a mist, will be stable at a lower relative humidity than a droplet of water. Therefore, once a fog is formed in an atmosphere containing sulfur dioxide, it will tend to be a more persistent fog than one in an unpolluted atmosphere. It will be a more objectionable one because of its corrosive and irritant character."

The report of the Committee on Public Health Relations of the New York Academy of Medicine is cited: "Inhalation of carbon particles and irritating fumes lower the resistance of the nasal mucous membrane, rendering it susceptible to acute and chronic infections which may involve the ear. Enlargement of the tonsils and redness and congestion of the pharynx and larynx have also been ascribed to atmospheric pollution. Smoke likewise irritates the membranes of the entire respiratory tract, predisposing to pneumonia and emphysema. Smoke diminishes the potential reserve, working capacity, and well-being of the individual and increases fatigue and irritability, whereas sunshine exerts an exuberant influence." - BAAP

248. Stern, A.C. (Editor): Air Pollution. Vol. 1. New York Academic Press, 1962, 656 pp.

B.D. Tebbens. Reactions in the atmosphere. A.J. Haagen-Smit. Air Ions. B.J. Steigerwald. Diffusion and stirring in the lower troposphere. R.C. Wanta. Atmospheric dispersion of stack effluents. G.H. Strom. Pt. II. - The effects of air pollution. Effects of air pollution on materials. J.E. Yocom. Effects of air pollution on visibility. E. Robinson. Effects of air pollution on plants. C.S. Brandt. Effects of air pollution on animals. H.E. Stokinger. Effects of air pollution on humans. J.R. Goldsmith. Pt. III. Measuring and monitoring air pollution. - Air sampling. E.R. Hendrickson. Source testing and monitoring. B.D. Bloomfield. Air analysis. M.B. Jacobs. Production of controlled test atmospheres. J.P. Lodge, Jr. Odor and its measurements. E.R. Kaiser. Meteorological measurements. E.W. Hewson. Automatic instrumentation. N.A. Renzetti. The air pollution survey. A.T. Rossano, Jr. Appendix: Characteristics of particles and particle dispersoids. Indexes. This book is concerned with the cause, effect, transport, measurement, and control of air pollution. It is intended for professionals, those trained in as wide a variety of callings as are represented among its authors: engineers, chemists, physicists, physicians, meteorologists, lawyers, agronomists, and toxicologists. This is a 2-vol. work, and it may be helpful to the reader who does not find the subject of his interest in vol. 1 to outline the contents in vol. II. It covers 4 major areas: the emissions to the atmosphere from the principal air pollution sources; the control techniques and equipment used to minimize these emissions; the applicable laws, regulations, and standards; and the administrative and organizational procedures used to administer these laws, regulations, and standards. - APCA

249. Stevenson, H.J.R.: The Effects of Physical Factors on Aerosol Formation from the Photochemical Reaction of Mixtures of Hydrocarbon, Nitrogen Dioxide and Sulfur Dioxide. In partial fulfillment of the requirements for the degree of Doctor of Science in Industrial Health. Univ. of Utah, 1964.

The objective of this investigation was to determine the effect of sulfur dioxide on the photochemical production of aerosols, to determine the relative ability of several hydrocarbons to produce aerosols and to determine the effects of several physical parameters. The variables were the type of hydrocarbon, the concentrations of hydrocarbon, nitrogen dioxide, and sulfur dioxide; the wavelength of illumination, the relative humidity, and the length of the reaction time. The reactions were performed in a chamber constructed of 6-inch pyrex pipe. Illumination was provided by 26 fluorescent blacklights, or by a combination of blacklights and fluorescent sunlamps. The reactions were effected under dynamic conditions, that is, the components were flowing through the pipe at a rate sufficient to subject them to residence therein for $\frac{1}{2}$ hour, 1 hour, or 2 hours.

It was observed that an aerosol was produced, in some reactions, in the absence of sulfur dioxide. On the other hand, the addition of sulfur dioxide produced more aerosol in most instances. One hydrocarbon (trans-2-butene) required sulfur dioxide for the production of an aerosol, when reacted photochemically with nitrogen dioxide.

Another hydrocarbon (cyclohexene) did not require sulfur dioxide to produce aerosol in a photochemical reaction with nitrogen dioxide. However, when both of the hydrocarbons were present in a photochemical reaction with nitrogen dioxide, the amount of aerosol was greater than that produced by one of them (cyclohexene) alone. The cyclohexene appeared to be performing a role for the trans-2-butene similar to that played by the sulfur dioxide.

Six and seven carbon olefins, whether cyclic or straight chain (cyclohexene, 1-hexene, 1-heptene and 3-heptene), produced aerosol photochemically with nitrogen dioxide, in the absence of sulfur dioxide. However, all of them produced increased aerosol when sulfur dioxide was added. The 3-heptene produced less aerosol than the 1-heptene, in the absence of sulfur dioxide, because of the smaller molecular fragment involved in the reaction. However, the 3-heptene reacted more rapidly than the 1-heptene, because of the internal position of the double bond, and the increase of aerosol, on adding sulfur dioxide, was greater in the case of 3-heptene than in that of 1-heptene.

Shorter wavelength of illumination had little effect, indicating, thereby, that the photochemical activation of sulfur dioxide is not responsible for its ability to react in the photochemical production of smog. - Author's Sum.

250. Sulfur dioxide sensitized photochemical oxidation of hydrocarbons. Science 131:1523-1524 (May 20) 1960.

Near-ultraviolet sunlight is absorbed by sulfur dioxide to produce electronically excited molecules, which react with n-butane in the presence of wet or dry air to produce an aerosol and eventually a liquid precipitate. The product is a heavily oxidized, sulfur-containing, organic strong acid. The possible role of these reactions in photochemical air pollution is discussed. - PHEA

251. Thomas, M.D.: Sulfur dioxide, sulfuric acid aerosol and visibility in Los Angeles. Internat. J. Air & Water Poll. 6:443-454 (Nov.-Dec.) 1962.

An automatic analyzer for simultaneous recording of sulfur dioxide and sulfuric acid aerosol in air has been used to monitor the atmosphere in Los Angeles. Downtown, when the base of the inversion ceiling and wind speeds were low and oxidants were high (Rule 57 days) the oxidation of sulfur dioxide to sulfuric acid was maximal. Acid levels reached 5-20 per cent of the total sulfur with sulfur dioxide levels of 5-20 p.p.h.m. In industrial El Segundo, the rate of oxidation of sulfur dioxide was about 60 per cent of the rate downtown under similar weather conditions. Presumably the accompanying smog concentrations were also lower in El Segundo. Visibility in areas immediately downwind from large consumers of fuel oil was reduced slightly on Rule 57 days, by burning oil containing 1.5 per cent sulfur instead of natural gas, but no effect was found at greater distances. Eye irritation downtown was independent of the amount of fuel oil burned. - Author's Abst.

252. Tufts, B.J., and Lodge, J.P., Jr.: Chemical identification of halide and sulfate in submicron particles. Anal. Chem. 30:300-303 (Feb.) 1958.

This technique, described in this paper, provides a method for the identification and size estimation of extremely small particles containing halide and sulfate. As the resultant reaction spot is larger than the original particle, it effectively adds to the already high resolving power of the electron microscope in identifying these ions. The reaction spots are distinctive and not readily confused with other substances in a heterogeneous sample. - Authors' Concl.

253. Van Den Heuvel, A.P., and Mason, B.J.: The formation of ammonium sulfate in water droplets exposed to gaseous sulfur dioxide and ammonia. Quart. J. Royal Meteorol. Soc. (London) 89:271-275 (April) 1963.

The role of formation of ammonium sulfate in water drops exposed to air containing known concentrations of gaseous sulfur dioxide and ammonia has been measured. The mass of sulfate formed is proportional to the product of the surface area of the drops and the time of exposure. Extrapolation of the laboratory results to the atmosphere suggests that the large condensation nuclei $0.2\ \mu < n < 1a$ of ammonium sulfate, found by Junge to be abundant in industrially polluted air, are formed by the absorption of SO_2 and NH_2 in cloud and fog droplets. - APCA

254. Vigliani, E.G., and Zurlo, N.: Chemical composition and particle size measurement of airborne dust in a hospital area in Milan. Med. lavoro 49:163-166 (March) 1958.

In a hospital area in the center of Milan the average airborne dust concentration was found to be 0.17 mg./m.^{3} in summer and 0.15 mg./m.^{3} in winter. Chemical analysis as well as microscopic and ultramicroscopic observations showed that the difference between winter and summer is due mainly to coal smoke and other combustion products deriving from heating plants, most of which use naphtha as fuel. Although a study carried out in a single location in the town does not allow drawing general conclusions, still it suggests that the amount of solid particles in the air of Milan is quite high during the winter and is more or less the same as found in other large industrial towns, both in Europe and in America. - APCA

255. Waller, R.E.: Acid droplets in town air. Internat. J. Air & Water Poll. 7:773-778 (Oct.) 1963.

Slides impregnated with indicators have been used in a cascade impactor to detect the presence of acid droplets in urban air. Some acid has been found at all times in London and the acid droplets are most numerous during fog. Much of the acid is contained in droplets of less than 1 μ diameter, but larger ones do occur and acid "rain" has been observed in some atmospheric conditions. - Author's Abst.

256. Waller, R.E., Brooks, A.G.F., and Cartwright, J.: An electron microscope study of particles in town air. Internat. J. Air & Water Poll. 7:779-786 (Oct.) 1963.

The electron microscope has been used in a further study of the nature of suspended particulate matter collected from the air of London and Sheffield. In addition to the particles of carbon, tar and ash which had been reported earlier, droplets containing dissolved salts and sulfuric acid have now been recognized as common constituents of urban air. - Authors' Abst.

257. Adams, D.F., Mayhew, D.J., Gnagy, R.M., Richey, E.P., Koppe, R.K., and Allen, I.W.: Atmospheric pollution in the ponderosa pine blight area, Spokane County, Washington. Indust. Eng. Chem. 44:1356-1365, 1952.

The ponderosa pine trees in the industrialized area north of Spokane, Wash., have exhibited a characteristic reddening of the needles since 1943, known locally as "ponderosa pine blight." The blighted area now embraces approximately 50 sq. mi. and the trees within a 3 sq. mi. area near the center are dead. As a portion of a comprehensive investigation, the concentrations of gaseous F and S compounds in the air during the growing season of 1950 have been determined through operation of 12 air-sampling stations and a mobile air-analysis laboratory. Throughout 2 mo. of observation, concentrations of oxidizable gaseous S compounds in the atmosphere sampled did not exceed 0.10 ppm. Analysis of F, representing gaseous, H_2O-soluble F-containing compounds, are tabulated according to average concentrations in relation to wind direction and air-sampling stations, also according to distance from damage center, and the influence of meteorological and topographic conditions in the area is discussed. The concentration of F was usually less than 5 ppb, but 3 samples showed more than 50 ppb. Analysis of rain H_2O samples obtained during each rainy period throughout Oct. and Nov. 1950 at 82 locations showed that the highest F concentrations fell in the center of damage, whereas many of the highest S concentrations bore no relationship to the location of the 3 major industries near the center of damage. In conclusion it is stated that the atmospheric concentrations of F present did not of themselves establish the minimum concentration of gaseous F compounds in the air required to produce typical F damage. The concentrations of gaseous S compounds were found to be too low to be an independent factor in the pine tree damage. However, the possible synergistic effects of sub-damage concentrations of SO_2 in admixture with gaseous F compounds must be thoroughly investigated before any conclusions concerning the possible causes of the pine tree blight can be drawn. - KB

258. Air pollution in Florida. A.M.A. Arch. Indust. Health 12:567 (Nov.) 1955.

At least 6 companies are engaged in the manufacture of sulfuric acid in central Florida. Five are in an area about six miles in length. For a distance of about half a mile around each plant there has been marked destruction of pine trees and slighter damage to other vegetation. There have been many complaints of throat and mucous membrane irritation. At the request of the local county health department management of these plants were advised of the complaints and informed that studies will be made. Only a few preliminary studies were made. The remainder of the study is continuing in 1955.

259. Air Pollution Measurements of the National Air Sampling Network. Analyses of Suspended Particulates, 1957-1961. USDHEW, PHSP 978. U.S. Government Printing Office, Washington, D.C. 1962, 217 pp.

This publication was prepared for the Natl. Conference on Air Pollution held in Wash., D.C., on Dec. 10-12, 1962. On Jan. 1, 1957, major revision of the network operations was initiated. With these revisions the network became truly "national." There are currently 250 sampling stations in the network, 213 urban and 37 nonurban. Of the urban stations, 73 sample every yr. and 140 sample every other yr. Thus, in any 1 yr. there are 180 stations actively collecting samples, 143 urban and 37 nonurban. Every yr. urban sampling stations are usually located in the largest city, by population, of the 50 states, the District of Columbia, and Puerto Rico. In addition there are frequently several every-other-yr. stations in operation, some of which have been operated during the off yr. by the respective State agencies. Particulate matter collected by the Natl. Air Sampling Network is made up of the small particles which remain in suspension in the air for varying periods of time. The national urban mean concentration of suspended particulates for 1957-61 was 104 µg./m.^{3} with a max. concentration of 1706 µg./m.^{3}. The frequency distribution of mean concentrations, which for 190 cities ranged from 46 to 224 µg./m.^{3} is shown graphically in a figure in the text. This information is contained in Part I of the publication. Other parts of the publication are concerned with Data tables: Sampling site description and participating organization; Analytic methods; Explanation of statistical terms. - APCA

260. Air pollution by smoke and sulfur dioxide in London during foggy periods, November 1959 to January 1960. Smokeless Air, Spring 1960, pp. 203-205.

During this period there were four fogs of relative importance. Measurements of air pollution were made by the Warren Spring Laboratory during the first two episodes in East Greenwich and during the second two near St. Giles' Circus. Results indicated that both sulfur dioxide and smoke concentrations rose sharply during the foggy periods and dropped off when the fogs lifted. Fairly good correlation was also indicated between smoke concentration and visibility during the episodes. - PHEA

261. Altshuller, A.P.: Atmospheric reaction studies related to air pollution. Arch. Environ. Health 8:27-30 (Jan.) 1964.

In many respects studies of pollution of urban adjacent rural areas by trace gases and particles cannot be separated from the study of the composition of the earth's atmosphere. Data already available indicate that carbon dioxide and sulfur dioxide produced in combustion processes may be affecting the composition of the general atmosphere. Although few detailed measurements of the geophysical levels of carbon monoxide, nitrogen oxides, methane, and other hydrocarbons are available, it is believed that production of these gases by man's activities eventually will result in increased levels throughout the atmosphere. It is essential that the atmospheric chemists obtain more detailed measurements of trace gases and particulates at remote locations on and above the earth's surface. Transfer of pollutants from urban regions to the general atmosphere makes it increasingly less likely that the values obtained will represent the natural composition of the earth's atmosphere. - Author's Abst.

262. Ambrose, P.M., Larson, L.P., and Stanley, B.I.: Sulfur and pyrites. In: Minerals Yearbook, 1961, USDIBM, vol. 1, pp. 1175-1198.

This paper reports on a survey of the production and consumption of sulfur in all forms in many parts of the free world. The United States production of sulfur, in all forms, increased at a greater rate than world output, mainly because new sulfur terminals were stocked with molten sulfur. The most notable event that occurred during the year was the conversion, by a large segment of the sulfur-consuming industry, to the use of molten sulfur.

In the section "Technology" authors describe new micromethods for determining sulfur in organic compounds by gas chromatography; a fluorsolvent process for acid gas removal; a new process to produce sulfur dioxide from sulfur and sulfur trioxide for liquefaction; and report on an investigation on preparation of sulfide minerals by biological methods.

Authors also report that an aerosol layer consisting mainly of sulfur particles was discovered in the atmosphere by workers at the Cambridge Research Laboratories of the U.S. Air Force (Chemical and Engineering News vol. 39, no. 17, April 24, 1961,

p. 59.). "This layer completely envelops the earth with a shell 3 miles thick about 11 miles above the earth. The existence of this layer was first indicated by air samples collected during studies of fallout distribution. Detailed studies showed that the concentration of particles between 0.1 and 2 microns in size within the layer was about 16 per cubic inch-three times the number at adjacent levels. Electron microprobe analyses of samples showed that the layer was about 85 percent sulfur; silicon, iron, and aluminum also appear in some samples. This analysis, together with particle absorbency determinations and electron diffraction studies, indicated that the particles were ammonium sulfate. Iron and silicon content of some samples may have been due to temporary fluctuations in micrometeorite influx. The aerosol layer was thought to originate at its observed position from hydrogen sulfide or sulfur dioxide that were chemically changed by sunlight or ozone. The layer may explain purple light, the red disk seen above the point of sunrise or sunset."

263. Amdur, M.O.: Report on tentative ambient air standards for sulfur dioxide and sulfuric acid. Ann. Occupat. Hyg. 3:71-83 (Feb.) 1961.

This report was prepared in September 1959 at the request of the State of California Department of Public Health for their use in connection with the establishment of Standards of Ambient Air Quality for their state and is published with their kind permission. The full responsibility for the personal opinions thus expressed rests with the author.

The first section presents ten statements about the toxicology of sulfur dioxide and sulfuric acid. Following each statement is a discussion of the literature which has led the author to reach such a conclusion.

The second section presents some values for tentative air standards which were intended as a starting point for consideration and review by the committees concerned. - Author's Abst.

264. An, A.S.: Sulfur dioxide in the atmosphere of Frunze. Sovet. Zdravookhr. Kirg. (Frunze) 3:56-58, 1959.

The concentration of SO_2 was measured at 12 places within the city during 10-day periods, both during house-heating and during warm weather. The SO_2 concentration reached max. levels nearest the source of the gas. Not more than 0.5 mg./m.^{3} was found near a vegetation-protected area. The effects of SO_2 on the human body are discussed. - APCA

265. Anon: Sulfur removal from power station gases. Chem. Tr. J. Vol. 152 (June) 1963.

Studies are being conducted at the Central Electricity Research Laboratory to devise a dry adsorption process capable of removing sulfur oxides from hot flue gases. Solid adsorbents ranging from active carbons to semi-conductive mixtures of oxides are used for this study. The most suitable process for using the adsorbents is a "falling cloud" technique in which a fine dispersion of adsorbent is allowed to cascade freely through the rising gas stream. High adsorption efficiencies for some adsorbents have been found and a pilot-plant examination is being carried out.

266. Anonymous: Smoke and sulfur: Attacks on smokeless fuels. Smokeless Air, Summer 1955, pp. 212-215.

Arguments that the real danger of smog is the emission of sulfur gases, which is not lessened by the use of smokeless fuels, are countered. Soot particles, by condensing water droplets, form drops of sulfurous and sulfuric acids, and, by intercepting the sunlight, lower the temperature and raise the humidity. Moreover, the smoke prevention program will result in greater use of gas, oil, and electricity, which will reduce the amount of sulfur dioxide emitted.

267. Arnol'di, I.A., and Velousova, A.Z.: Industrial air pollution in the Noril'sk area. In: Hygienic Problems of Human Adaptation in the Far North.Moscow, Medgiz, 1961, pp. 62-67.

Air pollution was noted regularly in the city of Noril'sk (a city north of the Arctic Circle), especially in the older part of the city. Studies showed the pollution levels to be very high in relation to the permissible limits for SO_2 and SO_3. The average amounts of SO_2 (in mg./m.^{3}) at various locations in the city were found to be: 1.34, 1.50 (in the old city), 1.24, 0.78, 0.54, 0.44, 1.13, and 0.55. A considerable amount of pollution by dusts, H_2S, and chlorides was also shown. Average levels of dust (in mg./m.^{3}) at three locations were: 0.64, 0.37, and 0.8. In the precipitated dust was found evidence of cobalt, lead, and several other substances which could not be considered as totally inoxious for humans, when appearing in the air. Interviews with inhabitants of the city indicated a close relationship between air pollution and the sanitary living conditions. The importance of the development of air pollution control systems, is noted. - APCA

268. Ascher, L.: Smoke-nuisance in large towns. Eng. News 58:434-435, 1907.

The following facts speak for the injuriousness of smoke and soot: (1) The increase in mortality due to acute pulmonary diseases which is to be observed in many civilized countries was greatest in industrial and not in agricultural districts. In the former it amounted in the case of infants to 600% in the course of 25 years. Here also there are additional differences, this mortality being higher in industrial neighborhoods having great generation of smoke (coal and Fe districts) than in such with less smoke (textile districts). Among the coal miners of the Ruhr district it is twice as high as among the inhabitants of an equal age of the entire Kingdom of Prussia; in England it is many times higher among colliers, coal heavers, chimney sweepers and soot dealers than among farm hands. T.B spreads more rapidly in smoky districts. (2) The conclusions derived from statistics that smoke and soot cause a predisposition to acute pulmonary diseases and a more rapid course of T.B. are confirmed by the following pathological reports. Rabbits which inhaled moderate quantities of smoke or soot for several weeks had acute inflamation of the lungs on inhaling microorganisms, whereas the control animals remained healthy, and in the same manner T.B. had a quicker course in such animals than in those which had inhaled little or no smoke or soot. The inhalation of H_2SO_4, an important constituent of smoke, also accelerated the course of T.B. in rabbits. In the case of guinea pigs, which had become anthracotic by remaining in a large town, T.B. had a more rapid course than in the case of the control animals. (3) Smoke and soot favor the formation of fogs: these, again, concentrate the injurious constituents of smoke. Smoke robs towns of a much larger quantity of sunlight than was supposed hitherto. (4) The fight against coal smoke in civilized countries is one of the most important hygienic problems of the immediate future; in many districts, indeed, it is the most important. It will only be successful when it rests on a broad scientific basis, and when chemical, meteorological, technical and social conditions are taken into consideration in the same manner as sanitary conditions. Technical progress, such as the invention of a cheap gas, may under certain circumstances solve the problem, e.g., land reform. (5) For the solution of such problems, in which all civilized countries are interested, an international course of action is to be recommended. - KB

269. Baulch, D.M.: Relation of gustiness to sulfur dioxide concentration. J. APCA 12:539-542 (Nov.) 1962.

The data presented in this paper have shown significant relationships between the two most common gustiness classes, types B, and D, and SO_2 concentration. Although the simplification of this method may be criticized from a theoretical point of view, it is felt that the Brookhaven classification of gustiness provides a useful index of turbulence for this type of analysis. Further application and refinement of the method will be necessary, however, before it will be satisfactory for use in determining atmospheric diffusion on a routine basis.

It is felt that effective application of this method of analysis could provide a useful tool for the development of a diffusion climatology for communities of all sizes. The economic advantages of utilizing gustiness data in addition to standard meteorological observations would make such a method especially valuable to smaller communities, for whom the cost of more extensive diffusion research is not prohibitive. - Author's Sum.

270. Beard, R.R., Horton, R.J.M., and McCaldin, R.O.: Observations on "Tokyo-Yokohama Asthma" and Air Pollution. Pub. Health Rep. 79:439-444 (May) 1964.

The authors visited Japan during February, 1963 as consultants to the Armed Forces Epidemiological Board in order to examine the problems of asthma reported among American Personnel. This paper summarizes the observations made on that trip.

271. Bell, F.A., Jr.: Short-term air pollution studies. Civil Eng. (Feb.) 1963.

1. Useful-though limited-air pollution data can be obtained by state and local agencies using short-term, low-budget air pollution measurement programs. 2. These studies provide valuable training and orientation for technical personnel regarding air pollution measurement programs. 3. Cooperative short-term air pollution measurement studies can be utilized to acquaint the public with local air pollution needs and programs. 4. While such studies of short duration are not designed to reveal the prevailing patterns of air pollution, they can serve to give a preliminary estimate of the types and amounts of air pollution present in the locale studied. 5. Short-term studies have revealed the presence of the photochemical type of air pollution in four of the five cities here discussed, that is, in Tucson, Phoenix, Fresno, and Washington, D.C. 6. Results of the short-term studies indicate that excessive amounts of particulate matter, haze, and smoke occur in the air of the five cities discussed at one time or another, according to such standards for air quality as those of Oregon and California. 7. Sulfur dioxide levels were found to be generally low in cities using primarily natural gas and, to a lesser extent, fuel oil for heating and combustion. However Lynchburg, although it is the smallest city in the group included in this report, uses a considerable amount of coal and had the highest measured levels of sulfur dioxide. - Author's Sum.

272. Bersin, R.L., Brousaides, F.L., and Hommel, C.O.: Monitoring atmospheric SO_2 employing inverse radioactive tracers. J. APCA 12:129-137, 146 (March) 1962.

Sulfur dioxide of the more important air pollutants is produced by the combustion of sulfur containing oils and coals. Most determinations are based on conductometric methods, which are not specific, or colorimetric methods, such as with pararosaniline hydrochlorite formaldehyde. The method described here offers the potential of development into a simple, portable, rugged, relatively inexpensive monitor adaptable to laboratory or field use. The basic operational system of the monitor is shown in figure 1. A series of experiments was performed to observe flow-rate dependence and through this to obtain a measure of the reaction efficiency. Data from repeated measurements under different conditions, which have been used to establish that the molar conversion of SO_2 to ClO_2 is considerably greater than 1, are shown. Further correlation between input SO_2 and output ClO_2 is illustrated in figure 7, where within the measurement errors the response can be considered linear, with constant conversion efficiency. - Authors' Introduct.

273. Bienstock, D., Field, J.H., and Benson, H.E.: Sulfur dioxide in atmospheric pollution, and methods of control. In Lodge, J.P., Jr. (editor): Atmospheric Chemistry of Chlorine and Sulfur Compounds. Geophysical Monograph No. 3, Am. Geophysical Union. Natl. Acad. Sc. - Natl. Research Council Publ. No. 652 1959 pp. 54-62.

Because most of the sulfur contained in fuels is converted to sulfur dioxide on combustion, the extent of atmospheric pollution by sulfur dioxide is naturally related to the quantity and sulfur content of the fuels consumed. Two general methods of approach are available for limiting pollution by sulfur dioxide: either by removal of sulfur from the fuel prior to combustion, or by removal of sulfur dioxide from the products of combustion. Processes for removing sulfur dioxide from flue gases are applicable to both fuel oil and coal. In the direct reduction of the sulfur content of coal prior to combustion, several methods are available: (1) mechanical cleaning of coal; (2) partial gasification and carbonization to form a low-sulfur char; (3) complete gasification and a subsequent removal of the sulfur in the form of hydrogen sulfide from the fuel gas. Methods of regenerating the spent absorbent and recovery of the sulfur products under study are: reduction of absorbent with a reducing gas; electrolysis of the metal sulfate to produce sulfuric acid and the metal or metal oxide; and thermal decomposition of the sulfate. After sufficient study has been made to evaluate different absorbents, investigation of sulfur dioxide removal will be conducted in pilot-plant equipment, using an actual flue gas and a falling bed of hot, granular solids. - APCA

274. Bloomfield, B.D.: Atmospheric pollution study of a nonindustrial area. Am. Indust. Hyg. Quart. 16:141-150 (June) 1955.

Airborne particulate matter and sulfur dioxide were continuously sampled at 8 stations in the St. Clair-Marine City (Mich.) area, a nonindustrial area about 40 mi. north of Detroit. Summary of findings: (1) Cities having little or no industry exhibit particulate dust loadings approaching levels determined in certain areas of Detroit where a high concentration of industry exists. (2) Country air, often referred to as clean, fresh, invigorating, was found to contain significant quantities of particulate matter. (3) Rainfall had a decided effect on the airborne particulate matter. The loading increased with a decrease in precipitation. (4) There is some indication that higher wind speed results in lower particulate matter loading by virtue of dilution. (5) Predominant elements determined spectrographically were calcium, silicon, aluminum, magnesium, lead and iron. (6) There is little or no correlation of the amounts of metallic constituents and particulate loadings determined. (7) Dust counts were made at 8 stations, indicating a median value of 0.9 million particles per cubic foot of air. (8) Sulfur dioxide concentrations were determined at 3 sampling stations and ranged from 0.02 to 0.08 ppm. Previous study data collected in Detroit indicated sulfur dioxide concentrations ranging from 0.05 to 0.10 ppm. - APCA

274a Bovier, R.F.: Sulfur-Smoke Removal System. Presented at the 26th Annual Am. Power Conference. Chicago, Ill., April 16, 1964.

Development of an economically feasible system for essentially eliminating all solids and most sulfur fumes discharged into the atmosphere while burning high ash, high-sulfur content bituminous coal in power plant boilers may solve one of our industry's oldest and most vexatious emission problems. The problem, of course, is how to effectively minimize or control the stack emission of fly ash and sulfur dioxide.

The new system, as developed through actual pilot plant operation, not only promises to successfully eliminate one of the remaining major emission problems associated with the burning of soft coal, but actually produces sulfuric acid of acceptable qualities and in quantities substantial enough for economic commercial use.

The purpose of this paper is to describe the unique system, and how it came about, to explain how it functions, to point out why it appears to be economically feasible, and to indicate its value as an additional major tool for improving the quality of atmospheric conditions in the vicinity of large, new, coal-burning electric generating stations. - Author's Introduct.

275. Bradley, W.H., Logan, W.P.D., and Martin, A.E.: The London fog of December 2-5, 1957. Monthly Bull. Ministry Health 17:156-166 (June) 1958.

A fog on December 2-5, 1957, is estimated to have caused between 800 and 1000 deaths in Greater London. Meteorologically it was neither as consistently dense nor were the levels of atmospheric pollution in most areas as high as previous fog episodes known to be associated with a similar high mortality. Conditions were the worst in the eastern parts of London and a higher proportion of deaths was noted in those areas. As in the case of the London fogs of Nov.-Dec. 1948, Dec. 1952, and Jan. 1956, and the Donora episode in 1949, it is noteworthy that deaths occurred on the 1st day of thick fog. There was also a marked early increase in the number of cases of acute illness necessitating admission to the hospital. Although in the 1957 episode there was an increase in atmospheric pollution before the onset of the thick fog, the increases in deaths and cases of sickness occurred before the atmospheric pollution reached a level which would until recently have been regarded as seriously high. This indicates the need for further investigations into the min. levels of fog and atmospheric pollution associated with increases in mortality and morbidity rates. Considerable statistical information is supplied by the 2 figures and 5 tables of the text. - APCA

276. Brandt, A.D.: Problems of air pollution. Iron Steel Eng. 27, No. 6:75-83, 1950.

This is a general discussion of the air pollution problem with respect to contaminants, meteorology and topography, effects and engineering and regulatory control. In particular, the data on SO_2 concentrations in Detroit, Philadelphia-Camden, Pittsburgh, St. Louis-E. St. Louis and Washington in 1936-1937 are quoted from Meller, H.B., Allen, J.D., and Sherrick, J.L.: Concentrations of volatile sulfur compounds in atmospheric air. Special Research Series, Bull. No. 1, Part 2, Air Hyg. Foundation of Am., Inc., Pittsburgh, Pa., 1938. The values were highest for St. Louis-E. St. Louis (total average-0.060 ppm), and then for Pittsburgh (0.038 ppm), for Philadelphia-Camden (0.022 ppm), for Detroit (0.014 ppm) and least for Washington (0.002 ppm). 33 references were cited. - KB

277. Braun, R.C., and Wilson, M.J.G.: The variation of atmospheric sulfur dioxide concentration with altitude. Internat. J. Air & Water Poll. 5:1-13 (Nov.) 1961.

A light-weight air sampler carried on a small captive kite-balloon has been used to determine atmospheric sulfur dioxide concentrations at heights up to 500 ft. Measurements were made at 2 sites, one built-up and the other open, in the London area. Concentrations up to 116 ppm were observed. On one day the concentration at 500 ft. was very nearly the same as that at 100 ft. (roof level), whereas on a clear night the concentration at 500 ft. was only 1/3 to 3/4 of that at 100 ft. On another occasion a high concentration was found at 250-350 ft. Measurements in 3 fogs showed that the concentration at 500 ft. did not differ greatly from that on the ground or at 100 ft. - Authors' Abst.

278. Burdick, L.R., and Barkley, J.F.: Concentration of Sulfur Compounds in City Air. USBMIC 7066, 1939.

This is a summary of the published results of various SO_2 investigations in the following cities: Chicago, Ill., 1937; Pittsburgh, Pa., 1927-32; Portsmouth, Va., 1926-27; Salt Lake City, Utah, 1919-21; San Francisco, Calif., 1913-14; Washington, D.C., 1926-28; Pittsburgh, Philadelphia, Washington, D.C., St. Louis and Detroit, 1936-37; other cities, 1936-37; Panama Canal, 1927-28; Berlin, Germany, 1922, 1931, 1937; Budapest, Hungary, 1932-34; Liege, Belgium, 1936; London and suburbs, England, 1923-27; cities of Great Britain, 1932-37; Prague, Czechoslovakia, 1929-30; and Austria, 1928. - KB

279. Burn, J.L., and Pemberton, J.: Air pollution, bronchitis, and lung cancer in Salford. Internat. J. Air & Water Poll. 7:5-16 (Jan.) 1963.

Daily measurements of smoke and sulfur dioxide pollution were made at 5 stations in Salford for 1958-59. The measurements were used to define 3 groups of wards, higher, intermediate, and lower pollution. All Ministry of Natl. Insurance certificates of incapacity from bronchitis issued to Salford residents over a 2-yr. period were analyzed in relation to air pollution levels. Deaths in men aged 45-64 in Salford for 1956-59 from all causes, bronchitis, lung cancer, arteriosclerotic heart disease, and vascular lesions of the central nervous system were also analyzed in relation to air pollution levels. In 4 out of 5 smog episodes during the period studied, the number of new spells of bronchitis increased more than 2-fold. The group of higher pollution wards showed higher bronchitis morbidity rates in men 45-64 than the other wards. - APCA

280. Burrows, I.E., and Lindsey, A.J.: A study of air pollution by analysis of particulate material collected from air filtration plants. Part III. The determination of insoluble matter and of iron in ash of total air solids. Internat. J. Air & Water Poll. 6:439-441 (Nov.-Dec.) 1962.

Iron, the fourth most abundant element on earth, is well known as a major constituent of solid air pollutants. Its origin is probably mainly from the ash of solid fuels and partly from the iron and steel industry. Some airborne iron compounds may originate from wear and corrosion of metal structures in urban locations. The ash obtained from solid air pollutants usually has a brown colour due to its iron content.

A series of possible reactions may give rise to the finely divided iron oxide in the air. In coal or other solid fuel furnaces the iron, often present as pyrites or marcasite (FeS_2), may burn first to oxide and simply emerge as such suspended in stack gases; or it could be reduced to iron, converted to carbonyl in zone where carbon monoxide is in sufficient excess and later burn again to finely divided oxide. Both the oxides, Fe_3O_4 and y-Fe_2O_3 are present in the air and both of these exhibit the marked ferromagnetic properties characteristic of air dust and air dust ash. In modern steel manufacture the increasing use of oxygen to remove various oxidizable impurities also produces large quantities of "fume" consisting of both Fe_2O_3 and Fe_3O_4 (Sarjant, 1959), and much of this material is very finely divided. In some cases 50 per cent of the fume consists of particles less than 1 micron in diameter with some less than 0·01 micron. Without doubt the burden of iron in air solids in the neighborhood of steel works is high because of this type of process. - Authors' Abst.

281. Bushtueva, K.A.: Threshold reflex effect of SO_2 and sulfuric acid aerosol simultaneously present in the air. In: Levine, B.S. (translator): Ryazanov, V.A. (editor): Limits of Allowable Concentrations of Atmospheric Pollutants. U.S. Dept. of Commerce, Office of Technical Services, Washington, D.C., Book 4, 1960, pp. 72-79.

The simultaneous inhalation of sulfur dioxide and of sulfuric acid aerosol in above threshold concentrations elicited reflex changes in eye sensitivity to light and in optical chronaxy, which approximately equalled the sum of changes brought about by the 2 pollutants individually. The simultaneous effect of sulfur dioxide and of sulfuric acid aerosol in concentrations equal to the limits of allowable concentrations correspondingly (0.05 mg/m^3 and 0.03 mg/m^3) elicited no changes in the curves of adaptation to darkness or in the optical chronaxy curve of man. The results indicated that the synergistic effect of sulfur dioxide and sulfuric acid aerosol simultaneously present was active only in concentrations which exceeded the limits of allowable concentrations previously adopted. Therefore, it is concluded that, even in the simultaneous presence of the 2 pollutants in the atmospheric air, the limits of allowable concentration previously adopted for each of the substances can safely remain in effect.

282. Campbell, J.A.: Carcinogenic agents present in the atmosphere and incidence of primary lung tumors in mice. Brit. J. Exptl. Pathol. 20:122-132, 1939.

In each case 75 mice were exposed to a moderate cloud of chimney soot and of exhaust soot for 10 min./hr., 6 hr./day, 5 day./wk. for a yr. 75 mice were also used as controls in each case. Experiments were also carried out in which 23-24 mice were painted twice/wk. with (a) 4 tar extracts (24 mice each) from road dusts for 6-7 mo.; (b) "tar" from cigarette smoke for 20 mo.; (c) benzene extract of cardboard for 12 mo.; (d) 2 tar extracts (24 mice each) from exhaust soot for 6-12 mo. and (e) tar from chimney soot for 6 mo. The mouse-skin tests showed that road dust tar contains potent carcinogenic agents as does chimney soot, but under ordinary conditions the effect of the latter in its action on the skin seems to be mitigated somewhat by the presence of the C of the soot, while the effect of the former seems to be aided by the presence of inorganic constituents. Of the 87 surviving mice, 16 of the skin cancer cases gave rise to metastases in the lung and primary lung tumors developed in 10 others. Under ordinary circumstances, the tar in cigarette smoke may occasionally produce hyperplasia and cancer of the skin after prolonged application. Seven (35%) of the mice surviving 10 mo. exhibited primary lung carcinoma. Tarry matters from the motor-exhaust soot and from the cardboard tested did not produce cancer when painted on the skin of mice, but 10 (50%) of the surviving mice painted with the former and 5 painted with the latter developed lung tumors. The results for primary lung tumors from the inhalation experiments, together with those done previously, are summarized. The % of normal control mice, living 10 mo. or longer, having lung tumors ranged from 8-20%; for those inhaling motor exhaust gases, 20 and 18%; chimney soot 26%; road dust for 1 wk. only, 30%; cigarette smoke, 30%; exhaust soot, 33%; road dust less tar, 45%; with tar, 74%; with tar plus CO, 47%. The age of the mice ranged from 664-919 da. It is considered that the inorganic constituents in the road dust (e.g., SiO_2, Fe) enhance or aid the effect of the tar, while, on the other hand, the C of soot tends to mitigate any effects of the tar present in producing tumors of the lungs. Irritation without inflammation appears to play a part in the genesis of these tumors both in control and experimental mice. Although some primary lung tumors in mice are simple adenomata, other tumors reveal characters of typical malignancy with production sometimes of metastases. Further examples of metastases have been obtained. - KB

283. Carroll, F.D., Crawford, S.R., Newall, H.E., and Weatherley, M.L.: Trends in the pollution of the air of Great Britain by smoke and sulfur dioxide, 1952-1960. Proc. Harrogate Conference, National Society of Clean Air, London, 1960, pp. 71-82.

This paper is attempting to estimate changes in the emission of smoke and sulfur dioxide in Great Britain since the enactment of the Clean Air Act. This act became law in 1956 and, although it has contributed to curbing emissions of smoke it apparently had no direct effect on pollution by sulfur dioxide.

284. Casarett, L.J.: Some physical and physiological factors controlling the fate of inhaled substances. II. Retention. Health Phys. (London) 2:379-386 (May) 1960.

Particulate material deposited in the respiratory tract behaves in a variety of ways. Certain aspects of the behavior of particles in the respiratory tract are reviewed. Emphasis is placed on relatively insoluble particles, deposition in the parenchymal regions of the lung and on the phagocytosis and its part in the mechanisms by which the particles are removed from the lung. The fundamental mechanisms of clearance are discussed, with some emphasis on those aspects which are pertinent to the calculations of the radiation dosage to the lung as usually performed. 65 references. - APCA

285. Challande, R.: Size and enumeration of atmospheric dusts according to altitude. Compt. rend. acad. sc. (Paris) 248:2233-2234 (April 13) 1959.

During a period covering the 1st 2 weeks of Oct. 1959, the dust content of the atmospheric air was studied in a laboratory situated at an altitude of 3.616 m. Dust collections were made using cellulose filters and a continuously-operating aspirator. The particles retained on the filter were then measured microscopically. In the range of 5 to 8 μ diam. the aspirated air was found to contain 206 particles/l. and represented an artificial radioactivity of 0.78×10^{-12} C/m.^{3}. Of these particles 91.2% were between 5 and 10 μ in diam.; 7.7%, between 10 and 50 μ; and 1.1%, greater than 50 μ. An estimation of the weight of the particles, assuming a specific gravity of 2 g./ml., would total 2×10^{-7} mg./l. of air. At 1 period in the study an electronic precipitation tube was used and attention was called to the submicroscopic-sized particles which were demonstrated to exist by use of the electronic microscope which was located in Geneva. Three sets of samplings taken under different meteorological conditions are reported, with no great variations in the average amounts of solid submicroscopic particles being found. During a dry period with the wind either from the south or east, an increase of 10% was noted in the total; in the absence of wind, and with a fog and a light fall of snow, a decrease of 20%. These results incline one to think of a constancy in the amount of submicroscopic particles in the air according to the altitude and to the location. However, the number of these smaller particles was found to be very high, being 4.5×10^6 particles/l. These unexpected results cannot be demonstrated by any weighable method. The total mass/l. of these particles is certainly less than 10^{-8} mg. (on the basis of the hypothesis of their specific gravity), consequently there must be an experimental error relative to the measurement of the mass of the particles much greater than a micron. At the indicated titer, it has been shown at the 1st stage of the Eiffel tower, and using the same equipment, that the highest average value was 3.8×10^8 particles/l., which is in the range of 100 times greater than that at the higher altitude of the laboratory. - APCA

286. Cholak, J.: The nature of atmospheric pollution in a number of industrial communities. Proc. 2nd National Air Pollution Symposium, Pasadena, Calif., May 1952, pp. 6-15.

Monthly samples of atmospheric pollution collected in Cincinnati in 1941 and from 1946-51 were compared with similar data from the following cities obtained either from the literature or from shorter studies of pollution in these cities with the number of samples collected, the range of concentration and the average or mean concentration of each of these being tabulated for the various areas (congested, industrial, residential): Baltimore, Charleston, W. Va., Chicago, Cleveland, Donora, Los Angeles and Salt Lake City. The ranges of average concentrations for each constituent in all of the cities were: CO_2, 0.033-0.39%; CO, 4.0-10 ppm; N oxides, $<$0.10-0.26 ppm; aldehydes, 0.04-0.18 ppm (formaldehyde); SO_2, 0.023-0.67 ppm; Cl^-'s, 0.016-0.078 ppm; NH_3, 0.014-0.04 ppm; F^-'s, 0.003-0.018 ppm (HF) and suspended PM, 0.18-0.87 mg./m.^{3}. The concentrations of the various components in the PM and the yearly variations in the average concentration of Pb in the atmosphere of various sections of Cincinnati are also tabulated. - KB

287. Cholak, J., Schafer, L.J., and Hoffer, R.F.: Results of a five-year investigation of air pollution in Cincinnati. Arch. Indust. Hyg. & Occupat. Med. 6:314-325, 1952.

Samples were obtained from 12-18 fixed stations (selected with respect to prevailing wind direction, population, density of traffic and altitude) for 3 or 4 days of each month from Nov. 1946 - Oct. 1951, inclusive. Sampling days were selected on convenience of the field crew, without regard to factors which might influence the concentration of pollutants. Average quantities of settled dust (in tons/mi.^{2}/mo.), collected at 4 representative stations for the 5 yr. were: I (suburban) 13.6, 14.6, 7.7, 9.2, 5.2, average 8.6, range 1.4-43; II (residential near downtown) 26.1, 38.0, 31.0, 28.5, 15.4, average 27.8, range 9.6-116; basin of city, III (industrial) 0.015, 0.025, 0.056. The concentrations varied seasonally and with the extent of commercial and industrial activity in the several areas of the city. Quantities of F's as HF (0.00-0.025 ppm) were extremely small and uniform throughout the city. Concentrations of Cl's were also uniform in distribution and ranged from 0.0-0.19 ppm. The mean concentrations of CO were: rural $<$5.0 ppm; residential 4 ppm; industrial-commercial 9.5 ppm. In a 2-day period when Christmas shopping was at its height, the mean CO concentration at 2 locations in the business area was 20.2 ppm. Range and average concentrations of CO_2 (%) were: rural 0.031-0.039, 0.033; residential 0.030-0.052, 0.037; commercial-industrial 0.032-0.060, 0.039; city proper 0.030-0.052, 0.038. Concentrations of nitrates ranged from 0.00-0.55 ppm, averaging 0.23; NH_3 0.00-0.089 ppm, averaging 0.023; aldehydes 0.00-0.27 ppm, averaging 0.07. The quantities of aldehydes seem to bear a direct relationship to the density of motor traffic. Ozone was not determined. Among the odors which can be detected and identified specifically at times are phenols, fatty acids and H_2S. Analyses of H_2S at times when the odor was recognized rarely showed concentrations in excess of 0.01 ppm in samples collected over a $\frac{1}{2}$ -hour period. - KB

288. Cholak, J., Schafer, L.J., Younker, W.J., and Yeager, D.: Air pollution in a number of American cities. A.M.A. Arch. Indust. Health 11:280-289 (April) 1955.

Determining the concentration of ozone (oxidant) in the atmosphere at ground level has been stimulated by reports from Los Angeles, where it has been observed that the concentration of oxidant increases with the severity of the smog. Measurement of iodine liberated from buffered potassium iodide solution is the best method for measuring ozone with continuous recording equipment. From the present knowledge of air pollution, consideration need be given only to the interferences by sulfur dioxide, chlorine, and nitrogen dioxide. This paper presents observations made in 10 American cities and suggests a method for calculating, from the interference by sulfur dioxide, the maximum concentration of oxidant which could have been present. Methods currently used for the determination of oxidant lack specificity but some basic comparative information concerning the probable maximum concentrations of oxidant (ozone) can be obtained. The same lack of specificity exists in the determination of sulfur dioxide, and it is clear that if the data on air pollution are to be used for comparative purposes the limitations of the analytical methods must be known. This applies not only to the contaminants discussed in this report but also to all gaseous pollutants, since almost without exception none of them are determined specifically by the analytical methods in current use. - APCA

289. Cholak, J., Schafer, L.J., Yeager, D.W., and Younker, W.J.: Gaseous contaminants in the atmosphere. A.M.A. Arch. Indust. Health 15:198-206, 1957.

In a continuing investigation of the levels of concentration of a number of gaseous pollutants in the urban atmosphere, the findings for 3 seasons of the year are reported for a station located centrally in Cincinnati. Continuous recordings of the concentrations of oxidant along with the automatic continuous collection of integrated 2-hour samples for SO_2 were obtained to observe the diurnal and nocturnal variations in the concentration of these gases. The levels of concentration of NO_2 and CO were obtained from grab samples collected several times daily during the period from Sept. through Dec., 1955, April 1956 and part of July 1956. An automatic and continuous NO_2 analyzer was placed in operation in April and also used for a 30-day period starting July 2, 1956. The instrumental and analytical technics are described and the findings are compared with those reported for Los Angeles and for a period of 85 consecutive days for Washington, D.C. Relationships among the concentrations of oxidant, NO_2 and SO_2 in the atmosphere and the evidence for the photochemical production of oxidant are discussed. - KB

290. Cholak, J., Schafer, L.J., Younker, W.J., and Yeager, D.W.: The relationship between sulfur dioxide and particulate matter in the atmosphere. Am. Indust. Hyg. A. J. 19:371-377 (Oct.) 1958.

In communities where coal is the principal fuel, sulfur dioxide and airborne particulate matter have long been considered important indices of air pollution, and more measurements have been made of these pollutants than of any other. This paper describes the features and the patterns of occurrence of these 2 pollutants, as they have been observed in Cincinnati since 1946. Because of the importance of the chemical reactions taking place between particulate matter and the gaseous contaminants of the air during periods of low wind velocity and high humidity, one of the important considerations in the chemistry of air pollution is the relationship between the total gaseous contaminants and related components of the particulate matter. The data obtained indicate that more than 90% of the sulfurous material in the air is gaseous in character. The samples which yielded these results were collected during periods when the meteorologic conditions were favorable for the dispersion of air pollutants. No data are available to show the relationships of total sulfur dioxide to sulfate in the aerosols during periods of weather conducive to the formation of smog. Because of the great improvement in air cleanliness that has occurred in the past few years, it may be necessary to explore these relationships under laboratory conditions. - APCA

291. Clayton, G.D., Brinton, H.P., Gafafer, W.M., Katz, M., Radcliffe, J.C., Baynton, H.W., Molner, J.G., and Frederick, W.G.: The Detroit-Windsor Air Pollution Study. Pub. Health Rep. 67:658-671, 1952.

The 6 major papers on the Detroit-Windsor air pollution study given at a symposium on April 22, 1952 in Cincinnati, Ohio and jointly sponsored by the American Conference of Governmental Industrial Hygienists and the American Industrial Hygiene Association are briefly presented.

Clayton, G.D.: Objectives of the Detroit-Windsor air pollution study, pp. 658-661. Brinton, H.P. and Gafafer, W.M.: Statistical analyses in air pollution studies, pp. 661-664. Katz, M.: Environmental studies--general area sampling, pp. 664-666 (for abstract, see Katz, M., Am. Ind. Hyg. Assoc. Quart. 13:211-225, 1952.) Radcliffe, J.C.: Industry's part in the study, pp. 666-668 (for abstract, see Radcliffe, J.C., Am. Ind. Hyg. Assoc. Quart. 13:206-210, 1952). Baynton, H.W.: Environmental studies--meteorological aspects, pp. 668-669. Molner, J.G. and Frederick, W.G.: Environmental studies--health aspects, pp. 669-671. KB

292. Clayton, G.D., and Giever, P.M. - Sitgreaves, R., Brinton, H.P., and Gafafer, W. (assisting): Report of Results of Sampling the Atmosphere in the Detroit River Area During 1951. Internat. Joint Commission, Technical Advisory Board on Air Pollution, U.S. Section, 1953, 55 pp.

A reference signed Jan. 12, 1949 by the Governments of the U.S. and Canada requested a detailed study be made, on both sides of the international boundary in the vicinity of the Detroit River, to determine the sources, nature and amounts of atmospheric contaminants from combustion of fuels and industrial processes; the effects of meteorological factors on the dissemination and diffusion of atmospheric contaminants; the effect of atmospheric contaminants on health, vegetation, safety and economy and the necessary controls, their cost and by whom the costs should be borne. The actual field work was started on the U.S. side in an SO_2 concentration. Approximately 70% of the SO_2 readings were <0.10 ppm. Highest average SO_2 concentrations and more marked diurnal peaks occurred in the winter. In high pollution areas, higher concentrations of SO_2 occurred in the morning hours (7 a.m. - 9 a.m.) during the winter season, and in the evening (7 p.m. - 10 p.m.) during the summer season. No relationship between cyclic weekly industrial activity and SO_2 concentrations could be determined. The highest concentrations occurred on week ends (Friday, Saturday or Sunday). The conclusion drawn was that no contaminant can be isolated as an index of total pollution in the area. 24 tables, 2 graphs, 46 figures, 1 illustration and 26 maps are included. - KB

293. Clayton, G.D., Giever, P.M., and Baynton, H.W.: Report of Results of Sampling the Atmosphere in the Detroit River Area During 1952. Internat. Joint Commission, Technical Advisory Board on Air Pollution, U.S. Section, 1954, 156 pp.

This report presents the environmental and meteorological findings obtained in 1952 and correlation of these data with those obtained in 1951. During the period extending from Aug. 7 - Sept. 19, 1952, 242 24-hr. samples were collected for total particulate matter (PM) by high volume air samplers at 9 sampling stations strategically located in Detroit.

Automatic Air Filter data showed similar trends at the 2 locations sampled. In a residential area, the darkest shading occurred at 5:00 a.m. followed by a rather rapid decrease in color density obtaining a low at 12:00 noon. Samples obtained in the downtown area followed the same general pattern with minimum and maximum density of shade occurring 2 hours later. These data indicate that there was a probable rhythmic pattern associated with the rise and fall of particulates regardless of sampling location in the Detroit area. Frequency distribution of the Thomas Autometer SO_2 half-hour average readings during 1952 were in remarkably close agreement in all concentration ranges with the data obtained in 1951. The average SO_2 concentration for the year was 0.06 ppm. Each day of the week also showed the same average value. Monthly average SO_2 concentrations were as follows: Jan. - 0.10, Feb. - 0.08, Mar. - 0.08, Apr. - 0.06, May - 0.05, June - 0.02, July - 0.02, Aug. - 0.03, Sept. - 0.04, Nov. - 0.07 and Dec. - 0.11 (instrument out of order in Oct.). The greatest % of peak values of SO_2 occurred between the hours of 12:00 midnight and 3:59 a.m., while the lowest % occurred between 4:00 and 7:59 p.m. During 1952, the highest momentary SO_2 concentration was 2.40 ppm which occurred in July. The SO_2 concentration at Station 11 was much higher during the sampling period of Jan. 11-31 than for the period July 25-Aug. 31, probably indicating that the concentration of SO_2 was more closely related to the time of the year than to sampling locations. A meteorological study of 1952 revealed that, in general, it was typical of the climatology of the area. Daily surface weather reports at Detroit City Airport and 4 radio soundings at Selfridge Field Air Force Base were used as indicators of stability from Aug. 7 - Sept. 19, 1952. PM samples collected in Detroit and Windsor were combined and averaged to establish, for meteorological comparisons, a daily pollution level. High pollution periods were concurrent with light winds. Rapid cleaning of the air was associated with increasing wind speed. High pollution was associated with high stability and above normal temperatures; low pollution was associated with high instability and cooler temperatures. The mean total particulate concentration for Detroit-Windsor on a day the predominant wind direction was NE was 100 µg./m.^{3} air, NW 180, SE 296, SW271. The lower concentrations obtained when the wind was from the northerly direction was explained partly by the greater instability and a predominance of lower than normal temperatures associated with the NE and NW winds and that just the reverse conditions are concurrent with the SE and SW winds. Cold frontal passages, in general, caused a reduction in pollution concentration. The effects of rainfall on pollution concentration was indeterminate. - KB

294. Commins, B.T.: Chemistry of town air. Research 15:421-426 (Oct.) 1962.

Several aspects of the chemistry of air pollution are discussed. These include the combustion of fuels, properties of air contaminants and the chemical reactions which take place in air. The concentrations of some air pollutants during high pollution in London are given. - Author's Abst.

295. Coste, J.H., and Courtier, G.B.: Sulfuric acid as a disperse phase in town air. Trans. Faraday Soc. 32:1198-1202, 1936.

A method of investigating the H_2SO_4 content of the air which does not involve the use of filters is described. The amounts of H_2SO_4 in central London were estimated to vary between 1 and 20 x 10^{-6} g./1000 l.; the SO_2 in the same samples of air varied between 0.10 and 0.50 ml. (equivalent to 440 and 2200 x 10^{-6} g. H_2SO_4). The maximum amounts of H_2SO_4 were usually registered in periods of calm and in foggy conditions, while the amounts were invariably small after rain. No exact relationship was established but, in general, conditions which favored high SO_2 content also favored high H_2SO_4 content. There was some evidence that the proportion of H_2SO_4 was greater at ground level than at 6th floor level. Some observations made at an outlying northerly suburb showed that while the SO_2 content was only 0.02 ml./1000 l. (equivalent to 44 x 10^{-6} g. H_2SO_4) the amount of actual H_2SO_4 was 4 x 10^{-6} g. - KB

296. Crowther, C., and Ruston, A.G.: The nature, distribution, and effect upon vegetation of atmospheric impurities in and near an industrial town. J. Agricult. Sc. 4:25, 1911.

Investigations and observations (1906-1910) at Manor Farm, Garforth, and Leeds are summarized. The work comprised analyses of rain samples and the effects of certain classes of atmospheric impurities upon vegetation. Rain samples were assessed for their impurities. Atmospheric pollution influences plant life by (a) reducing intensity of sunlight, (b) blocking stomatal openings, and (c) exerting a toxic influence through the sulfide constituents of the air. This influence affects the plant directly or indirectly through the soil.

Controlled experiments with timothy grass demonstrated that acidified water of 16 parts sulfuric acid per 100,000 parts water, used for irritation proved fatal to the grass in little over a year. At 32 parts per 100,000 the grass died in six months, and no vegetation was visible the following spring. Other concentrations of lesser amounts were used, and it was observed that in every case the yield steadily decreased with increased acidity of the water. The effects in this respect were cumulative. Concentrations showing this cumulative effect compared with concentrations of acid in rain water falling in industrial areas. The experiments thus were analogous to natural events inasmuch as concentrations of acid in the water were comparable. The cumulative effect upon timothy grass resulted in a product poorer in protein and richer in crude fibre, and thereby less nutritious - BAAP

297. Cummings, W.G., and Redfearn, M.W.: The concentration of sulfur dioxide in the atmosphere near power stations. J. Inst. Fuel 32:358-363 (Aug.) 1959.

Microquantities of sulfur dioxide were measured near 11 power stations using the Central Electric Research Laboratory (CERL) portable sulfur dioxide meter. (J. Inst. Fuel 30:628, 1957). Sulfur dioxide levels were recorded with details of weather, wind speed, stack heights, station load and sulfur content of the fuel. Background levels of 0 to 0.1 ppm were measured. Maximum concentrations beneath the plumes and down wind various distances from the sources ranged from 0. to 0.3 ppm. The ability of the CERL portable sulfur dioxide meter to measure microquantities of sulfur dioxide, and its usefulness as a rapid survey meter is illustrated.- PHEA

298. Dean, R.S., and Swain, R.E.: Report Submitted to the Trail Smelter Arbitral Tribunal. USBMB 453, 1944, 304 pp.

This report presents an extensive study of the operational features of Trail Smelter and especially of the meteorological situation in the Columbia River Valley near Trail, B.C. (the latter study by E.W. Hewson and G.C. Gill). The 3rd part of the report presents the seasonal meteorological control measures adopted during a trial period, with the corresponding record of smelter operation and SO_2 recording. SO_2 concentrations ranged up to 2.40 ppm. In conclusion it is stated "that the extensive investigation of air movements in the Columbia Valley which has been in progress for over 2 years past with relation to the distribution of SO_2 from the smelter stacks has indicated that these movements may be sufficiently rationalized to make possible the control of the gas concentrations occurring across the International Boundary in the U.S. on a meteorological basis. It has not been possible during the relatively short period this investigation has been in progress to reduce such meteorological control measures to a hard and fast regime. But much progress has been made and the ground work for the development of a simplified and sound practice has been laid." In the author's judgment, "if an intelligent attempt is made to make use of the guiding principles set down in this report and to test and improve them during periods of greater SO_2 emission that may occur in the future, a complete solution of the problem of damage to vegetation in the U.S. can be reached without an arbitrary limitation on the total amount of SO_2 emitted by the smelter." - KB

299. De Bary, E., and Junge, C.E.: Distribution of sulfur and chlorine over Europe. Tellus 15:370-381 (Nov.) 1963.

The distribution of mean concentration of sulfur and chlorine in the air and precipitation over north-western Europe are illustrated by maps. Assuming that chloride is a conservative property of sea spray particles and that there are no other sources for chloride than sea spray the excess SO_4-S has been computed on this basis. The ratio of concentration of air/precipitation for sulfur and chlorine are also illustrated.

300. Dechigi, M., and Paccagnella, B.: Observations and considerations on the problem of air pollution in the region of Mestre-Marghera (Venice). Arch. Hyg. & Bakteriol. 140:44-51, 1956.

On the basis of 803 analyses of air samples, the problem of air pollution at Mestre-Maghera, near Venice, Italy, is discussed, and the average maximum concentrations of SO_2, NO_2, F and suspended matter are illustrated in 4 figures. The considerations that had to be taken into account before establishing the final over-all working plan included the experiences derived from similar investigations carried out in other countries, the geographical and meteorological conditions, various financial and time factors as well as the location of the particular industrial plants under investigation. The collection of air samples was carried out mainly during the period between April and Aug. at stationary sampling stations for monthly readings which are still being continued and with mobile sampling posts for a variety of readings. The instruments and methods employed are described. Frequently, the highest concentrations were detected not in the immediate vicinity of the industrial plant giving off effluents containing SO_2, NO_2 and F, but at a certain distance. It is intended to devote further studies to the problem of correlating the combined action of the various air contaminants, the temperature inversion and the smog which often prevails in the area during the winter months, with the development of the severe respiratory disturbances which, according to the author, occur among the population of this region and which always show a marked increase during the winter months. The figures, indicating no units of measure, as recorded on charts for the area under consideration, are of the following magnitudes: SO_2, 0.009-0.44; NO_2, 0.008-0.048; F, 0.004-0.145; suspended dust, 347-5486. - KB

301. Dohan, F.C.: Air pollutants and incidence of respiratory disease. Arch. Environ. Health 3:387-395 (Oct.) 1961.

A high correlation ($r=0.964$: $P=0.001$) has been found between the mean concentration of "suspended particulate sulfates" in the city air and the incidence rates (mean of 3 years) of respiratory diseases lasting more than 7 days in women working in 5 cities. This would suggest that susceptibility to, or duration of, common viral respiratory infections is increased or that virus viability is enhanced by exposure to the air pollutants measured as sulfates (or to precursors, derivatives, or synergistic combinations). The incidence rates of respiratory disease subgroups and of various nonrespiratory illnesses lend support to this view. Indirect evidence indicates that the age distribution of the populations at risk, conditions at work, and social and climatic factors do not account for the fivefold intercity variation incidence of respiratory disease. - Author's Abst.

302. Drinker, P.: Atmospheric Pollution. Indust. & Eng. Chem. 31:1316-1320 (Nov.) 1939.

Atmospheric pollution implies abnormal concentrations of some substance in air. Excess nitrogen, carbon dioxide, or minute amounts of chlorine are evidences of pollution just as much as is common smoke. The polluting agent may be a gas, liquid (mist), solid, or even emanations as from radium. No hard and fast rules can be set as to what concentrations constitute pollution, but any departure from normal air is presumed to be evidence of pollution. The polluting agent may be harmful to plant and animal life, it may be a nuisance and dirty our clothes and buildings, it may form explosive mixtures with air, it may be harmful to machinery or to a manufacturing process, or it may be detrimental to human health.

Pollution is usually man-made (e.g., stack gases) but can be simply the result of natural phenomena (fogs or dust storms). Stack pollution is preventable and appropriate control measures can be enforced. Fog control is still in the experimental stage. Some pollution problems have been solved in order to prevent the loss of valuable material. Others are controlled because the manufactured product is improved by freeing it from contaminants. But many instances of needless pollution are ignored until expensive damage suits force control. Industrial chemists are often required to estimate the concentration of these various contaminants. Concentrations range from grams per liter to micrograms per cubic meter. Some of the contaminants can be recorded automatically; others must be sampled as often as conditions dictate. Examples of various types of contaminants are given, together with methods for estimating and controlling them. Author's Abst.

303. Dubrovskaya, F.I.: Hygienic evaluation of pollution of atmospheric air of a large city with sulfur dioxide gas. In: Levine, B.S. (Translator): Ryazanov, V.A. (editor): Limits of Allowable Concentrations of Atmospheric Pollutants. U.S. Depart. of Commerce, Office of Technical Services, Washington, D.C., Book 3, 1957, pp. 37-51.

A study was made of the degree and extent of Moscow air pollution with sulfur dioxide. It should be noted in this connection that the limit of allowable concentration of SO_2 previously adopted by the Chief Sanitary Inspection of the U.S.S.R. at the recommendation of the Committee on Allowable Concentration Limits of Air Pollutants was of a temporary character and that one of the aims of this study was to check the correctness of that recommendation. The limit of allowable SO_2 concentration recommended by the Committee was arrived at by determining its threshold action on plants, which was 0.9 mg/m^3 for short and 0.5 mg/m^3 for long time exposure, and its threshold odor perception by man, which was 4 mg/m^3.

The re-examination was limited to short time maximal single SO_2 concentration exposures. Two methods were employed: 1) determination of the threshold of odor perception; 2) determination of SO_2 threshold reflex effect on the sensitivity of the optical light analyzer. A special assembly was used in the determination of SO_2 threshold of odor perception which made possible the maintenance of constant SO_2 concentrations during test observations. Odor perception threshold tests were made on 12 persons paralleled by control tests. Most test subjects were of an age at which, according to reports in the literature, odor perception was at its highest. Sulfur dioxide concentrations of 0.5 up to 13 mg/m^3 were used in 530 threshold determinations.

304. Dubrovskaya, F.I.: Changes in atmospheric pollution in a large city and methods of smoke abatement. Gigiena i Sanit. (Moscow) 23:69-71 (Jan.) 1958.

An investigation of air pollution in the Moscow region has been conducted for the last several years by the Moscow Scientific Research Inst. of Sanit. and Hyg. of the Dept. of Public Health. Compulsory fly-ash control has been imposed on all heating installations, electric power plants, and industrial plants using boilers. Ash collectors in the industrial and power plants were introduced in 1949. Since 1948, the Institute has conducted a systematic study of the more frequent pollutants. Between 1948 and 1956, 16,136 tests have been made at 4 city locations, all of them removed from stacks. Dust concentration, during the 9 years of observation, has been found to be highest during the heating season, often exceeding permissible limits (0.5 $mg./m^3$ of air). Thus, in spite of much progress made, actual conditions do not as yet conform with sanitary requirements. To obtain a reduction of atmospheric dust, the following measures are recommended: (1) continued installation of large heating plants permitting the elimination of numerous small boilers, and construction of such plants, as well as power plants, outside the city; (2) use of gaseous fuels in all boiler-operated heat, power, and industrial plants; (3) until gas has been installed, all these plants should be fueled with coal of small ash content and should be supplied with effective fly-ash collectors; and (4) electrification of the railroads. - PHEA

305. Dyktor, H.G., and Goldston, L.N.: The effects of the steel industry on atmospheric pollution in the Cleveland area. Indust. Hyg. Newsletter 11: 22-23, 1951.

The plan of survey and sampling procedures of a study of the air pollution load in the Cleveland area with the steel industry in operation and while the steel industry was closed by a strike are discussed. 546 air samples of 1 hour's duration were taken and analyzed and 120 filter disks were used for the determination of shade number, i.e., the soiling effect of air-borne dust. SO_2 during the steel strike ranged from 0-0.389 ppm, but only 1 sample was in the range of 0.290-0.389 ppm air in the southern area of the valley. After the steel strike, the range was from 0-0.489 ppm, but again only 1 sample was in the range of 0.390-0.489 ppm in the northern area of the valley. The mean SO_2 concentration for the strike period was 0.034 ppm and for the poststrike period 0.050 ppm. This increase is not significant. F^-'s during the steel strike ranged from 0-50.0 µg./m.^{3} or over, and there were 6 samples of $>$50.0 µg./m.^{3} air in the southern area of the valley. After the steel strike, the range was from 0-50.0 µg. or over, and there were 4 samples of $>$50.0 µg./m.^{3}, again in the southern part of the valley. The mean F^- concentration for the strike period was 11.59 and for the poststrike period 11.12 µg./m.^{3}. While the foregoing 2 contaminants do not seem to have been much affected by the absence or the presence of the steel-making activities, yet the latter had an appreciable effect on the soiling value of the air-borne dust. Based on a necessarily arbitrary unit, the over-all soiling range during the poststrike period was roughly 50% greater than during the strike. There is no doubt that the emissions of iron oxide and carbonaceous matter made their substantial contribution to the soiling effect of air-borne dust, especially in the northern half of the valley. - KB

306. Firket, M.: The cause of the symptoms found in the Meuse Valley during the fog of December 1930. Bull. Royal Acad. Med. Belgium 11:683, 1931.

Certain symptoms common to all were painful irritation often mounting to an active retrosternal pain, and extending along the outer edge of the ribs; attacks of coughing, dyspnoea, often paroxysmal; and prolonged expiration. Adrenalin often gave relief. Those previously affected with asthma or heart disease developed symptoms of shock. In addition to the tracheobronchopulmonary irritation, a large number showed signs of laryngeal irritation causing cough and modification of the tone of the voice. There was also some nausea and vomiting, lacrimation, and tenacious sputum. In one case there was desquamation of the mucosa of the entire buccal cavity. There was no diarrhea, neuritis, albuminuria, hepatomegaly or sensory disorders. "There is no reason to believe that only the ill and the aged were seriously affected by the toxic attacks." Persons were attacked who had not left their houses for several weeks or who had not gone out in the fog. At autopsy there was congestion of the mucous membranes of the air passages. All the symptoms and all the lesions found could be sufficiently explained by a local irritation of the exposed mucous membranes. - APCA

307. Firket, J.: Fog along the Meuse Valley. Trans. Faraday Soc. 32:1192, 1936.

Between December 1 and 5 of 1930, a heavy fog covered a large part of Belgium. A number of people were made ill; several hundred were severely attacked with respiratory symptoms, and 63 died on December 4th and 5th after only a few hours of illness. Many cattle had to be slaughtered. On December 6, the fog disappeared. Public opinion was deeply affected by the episode, and an investigation was started immediately. All the sick people felt retrosternal pain, had fits of coughing, and dyspnoea, and some had asthmatic attacks. In those who had asthma, cardiovascular collapse and symptoms of shock complicated the picture. In those who did not have asthma, hyperpnea, cyanosis and a tendency to frothy sputum developed. The autopsy reports indicated that the noxious substance was inhaled during the last few hours of life. The first symptoms began on the third day of the fog. Respiratory symptoms disappeared on the sixth day when the fog abated. Symptoms were observed by the people throughout the valley at about the same time. Chemical Analyses: The chemists found thirty substances polluting the atmosphere, with maximum concentrations reached by carbon monoxide, carbon dioxide, nitrous gases, sulfur dioxide, and hydrogen fluoride. Through deduction, observation, and data obtained, sulfur dioxide appeared to be issued in the largest amount in the whole valley as a result of burning coal. Part of the sulfur dioxide was oxidized into sulfuric acid. Only by the action of sulfur pollution could the simultaneous illnesses occurring along the entire valley be explained. The pathological findings also favored sulfur dioxide and sulfur trioxide as the offending gases. - BAAP

308. Gartrell, F.E., and Carpenter, S.B.: Aerial sampling by helicopter: A method for study of diffusion patterns. J. Meteorol. 12:215-219 (June) 1955.

The trend toward larger and larger steamelectric plants, using fuels with high sulfur content, is resulting in increased attention to studies of diffusion of power-plant stack gases in the atmosphere. This article describes a method for sulfur-dioxide air-pollution sampling, utilizing a continuous analyzer and recorder operated in a helicopter. This method was developed to overcome many of the limitations of conventional sampling methods encountered in diffusion studies at one of the large coal-fired steamelectric plants in the Tennessee Valley Authority power system. - Authors' Abst.

309. Gillespie, G.R., and Johnstone, H.F.: Particle-size distribution in some hygroscopic aerosols. Chem. Eng. Progr. 51:74-F to 80-F (Feb.) 1955.

The selection and design of aerosol-removal equipment depend largely on knowledge of the size of the particle. In the present work the distribution of particle sizes of aerosols of sulfuric, phosphoric, hydrochloric, hydrobromic, and chlorosulfonic acids was measured by means of a four-stage, high-velocity jet impactor. The effect of the relative humidity of the air stream, the addition of foreign nuclei, the concentration of the aerosol particles, and time on the size distribution was studied. The aerosol was formed almost instantaneously by the rapid and continuous mixing of a hygroscopic vapor with a moist air stream. The particles attained equilibrium with their surroundings in a fraction of a second by taking up water vapor. If the number concentration was greater than 10^6 particles / cc., the particles continued to grow by coagulation. The particle size, which ranged between 0.1 and 6.0 μ diam., appeared to depend primarily on the method of formation of the nucleus. The size distributions followed the log-probability function from which the number of particles per unit volume of gas was obtained. The jet impactor was shown to be readily adaptable to field work. Samples of sulfuric acid mist from the waste gases of a contact-acid plant showed the particle-size distribution to be nearly identical with distributions made from sulfur trioxide and water vapor under similar conditions in the laboratory. - APCA

310. Giovanardi, A., and Grosso, E.: Investigation of atmospheric pollution in the city of Milan. IV. Behavior of the sulfur compounds. Nuovi Ann. Igiene e Microbiol. (Rome) 9:1-13 (Jan.-Feb.) 1958.

Descriptions are given of the methods used and the results obtained from a series of tests on the sulfur dioxide content in the air in Milan, in relation to season, fog conditions, and the topography of residential and industrial zones. On the basis of data revealed in the investigation, the authors conclude that air pollution in the residential areas of Milan (the central and paracentral areas) may be attributed mainly to poorly controlled combustion in the home heating plants during the winter season. - APCA

311. Goetz, A.: Origin, behavior, and determination of submicron aerosols in smog. Staub 20:303-308 (Aug.) 1960.

Smog generation occurs in heavy automobile traffic and large industrial centers. It is contingent upon the coexistence of uncombusted hydrocarbons HC, NO_2, SO_2 at 10^{-7} concentration in stagnant air masses exposed to intense irradiation. It represents the early phases of a photochemical reaction among these components which produces highly polar oxidant compounds. Their associative acidity in the presence of natural aerosols causes particle growth well into the 10^{-5} cm. range resulting in visibility reduction and synergistic irritation. This effect increases with the olefin concentration of the HC. With age the particle size gradually vanishes due to further oxidation into volatile components, CO_2, H_2O, etc. With the aerosol spectrometer the growth and subsequent decline of the particle size can be traced quantitatively. - APCA

312. Goldwater, L.J., Manoharan, A., and Jacobs, M.B.: Suspended particulate matter. Arch. Environ. Health 2:511-515 (May) 1961.

Suspended particulate matter in indoor and outdoor air was determined at 30 locations. Indoor air values ranged from 60 µg. to 539 µg. per cubic meter with a mean weight of 158.0 µg. per cubic meter. Outdoor air values ranged from 41 µg. to 938 µg. per cubic meter, with a mean weight of 211.5 µg. per cubic meter. The ash of the indoor samples ranged from 1.5% to 38.0% with a mean of 13.3%. The ash of the outdoor samples ranged from 2.1% to 80% with a mean of 29.3%. The differences between the ash content of indoor and outdoor air were statistically significant. Authors' Sum.

313. Goossens, J.F., and Lafontaine, A.: Chemical air pollution in modern cities and the problem of fumes from internal combustion engines and heating installations. Arch. Belges Med. Sociale, Hyg., Med. du Travail et Med. Legale. 16:217-237 (May) 1958.

In this paper the authors have reviewed in general terms the problem of atmospheric pollution in towns, paying particular attention to exhaust fumes from petrol and diesel engines.

Air contaminants are discussed under three headings--(a) industrial and domestic sources; (b) radioactive material from nuclear test explosions and from nuclear power stations; (c) carcinogenic substances, notably 3,4 benzpyrene and metallic contaminants such as arsenic, beryllium, chrome and nickel.

In air samples from the streets of Brussels the authors found the average concentration of carbon monoxide (CO) to be 10 p.p.m. Their results agreed with similar findings in Paris but the authors point out that in the latter investigation the air in some thoroughfares had a concentration of 100 p.p.m. of carbon monoxide and in one instance the figure was 500 p.p.m. (MAC 100 p.p.m.)

Although Dettling found 5 mgm. of lead per cubic meter of exhaust fumes at source when tetra-ethyl lead had been added to petrol, the general level of lead in the air of Cincinnati was found to vary from 0.1 gm. to 12 gm. per cubic meter, this being very much below the maximum allowable concentration which has been given as 150 gm. per cubic meter.

The authors go on to describe the irritant effects of sulfur dioxide (SO_2) and refer to the smogs of Los Angeles and London and other places. They point out the importance of the psychological effects of persistent smog, and suggest that the increased absorption of ultra-violet light under these conditions may contribute to a reduction in resistance to infection.

The composition of exhaust fumes from petrol and diesel engines is dealt with in some detail and interested readers are referred to the original article. The importance of good maintenance of motor-vehicle engines is stressed.

The authors then make a number of suggestions for reducing atmospheric pollution from these sources, among them being more attention to engine design, more research on fuels and better traffic planning to keep vehicles moving steadily with less stopping and starting.

A bibliography and a table of maximum allowable concentrations of toxic substances are given. 52 references. - PHEA

314. Gore, A.T., and Shaddick, C.W.: Atmospheric pollution and mortality in the county of London. Prevent. & Social Med. 12:104-113 (April) 1958.

An examination of mortality experienced in London during periods of fog in association with indexes of air pollution suggests a critical level of 4 times the customary winter average of air pollution above which a fog will cause marked immediate excess mortality. By the methods used in this investigation, no significant relationship between mortality and exposure to smoke and sulfur dioxide was demonstrated over a 2-year period. A critical level of one or both, in combination that would be directly associated with increased mortality, is not thereby excluded. There may also be other types of pollutants more dangerous than either. If the Clean Air Act of 1956 has the effect of reducing the amount of smoke in the atmosphere, it may be possible to assess with greater clarity the respective parts played by sulfur dioxide and smoke. - APCA

315. Grafe, K.: Winter temperature, sulfur dioxide immission and emission. Staub 23:557-559 (Dec.) 1963.

The average values of continuous sulfur dioxide immissions measured in the inner town of Hamburg are compared with the average values of temperature in the winter-half of the years 1958/1959 to 1962/1963. The average SO_2-values are, furthermore, contrasted with the falling SO_2-emissions of an oil refinery. The chances in SO_2 compass-charts for the winter-half of the years 1958/1959 compared to 1962/1963 now show recognizable dependence on a single emitter. With similarly or still further regressing SO_2-emissions and also paying regard to clean-air requirements, it will not again be possible to reach as high average immission values, even during hard winters, as in 1958/1959. - APCA

316. Greenburg, L., and Jacobs, M.B.: Sulfur dioxide in New York City atmosphere. Indust. Eng. Chem. 48:1517-1521 (Sept.) 1956.

The work of the Department of Air Pollution of the City of New York for the past two years shows that seasonal and daily variations are principally due to the use of fuel for the production of heat, light, power, and hot water, and for transportation. Other sources, such as the incineration of rubbish and refuse, trash fires, and bonfires, also contribute. The highest concentrations of sulfur dioxide occur during temperature inversion periods. In all such instances weather conditions generally extending far beyond the New York City area itself are the controlling factor. The concentration of sulfur dioxide falls off with increasing distance from the center of a city. Marked geographical variations do occur at times as a result of industrial contamination. - Authors' Concl.

317. Grosso, E.: Investigation of atmospheric pollution in the city of Milan. VI. Presence and behavior in the city atmosphere of contaminants of various origin--carbon monoxide, carbon dioxide, hydrogen sulfide, chlorine, fluorine, ammonia, and nitrogen oxides. Nouvi Ann. Igiene e Microbiol. (Rome) 9:31-36 (Jan.-Feb.) 1958.

Results are reported of a first series of investigations carried out on the air pollution of the metropolitan area of Milan. Determinations were made of carbon monoxide and other pollutants; carbon dioxide, hydrogen sulfide, chlorine, fluorine, ammonia, and nitrogen oxides. The carbon monoxide concentration in the zones of highest traffic (near the semaphores and in a tunnel) was never higher than 62 p.p.m. There was no evidence of hydrogen sulfide, chlorine, or fluorine in the central zones of the city; these elements, however, have been demonstrated in high concentrations in the neighborhood of an enamel varnish factory situated in a suburban zone. High concentrations of carbon dioxide were shown both in the central zones (residential) and in the industrial zones. The concentrations of ammonia and oxides of nitrogen in the peripheral and central zones of the city never surpasses 0.72 and 0.05 p.p.m. respectively. - APCA

318. Grosso, E., and Massarani, E.R.: Behavior of SO_3 in the city of Milan, Italy, as determined by the lead peroxide candle method. Ingeneria Sanitaria 6:201-207 (Nov.-Dec.) 1959.

This article reports the SO_3 content of Milan's atmosphere, measured at 12 stations in the city over a three year period (1956-1958). It provides information on methods used and shows seasonal and topographical variations found in the SO_3 content of the atmosphere of Milan, Italy. - PHEA

319. Haehnel, O.: Carbon dioxide and sulfur dioxide content of Berlin air. Z. Angew. Chem. 35:618-620, 1922.

This paper deals with the effect of chemical substances in the air on materials which have been up to now considered to be indestructible. Comparisons are made between rural and urban areas. Air samples are analyzed.

320. Halliday, E.C., and Kemeny, E.: Air pollution concentrations in East London. Pub. Health (Johannesburg) 63:27-29 (May) 1963.

In March 1963 the Air Pollution Research Unit of CSIR (Council on Scientific and Industrial Research, South Africa) published a report on the measurement of smoke and sulfur dioxide in four towns in South Africa. In that report it was indicated that the annual pattern of sulfur dioxide concentrations in East London differed markedly from the pattern in Johannesburg, in Pretoria, and in Durban in that the maximum of concentration was reached in the summer instead of in the winter, and the actual values were twice what they were in Pretoria. This report describes a further study, to test the validity of this observation, of the mean values of sulfur dioxide for each of 9 sampling stations in East London for (a) the months of May, June and July and (b) the months of November, December and January. It is concluded that the pattern of sulfur dioxide concentration is quite in keeping with the suggestion that a high proportion of the sulfur dioxide in the town comes from the plume of the smoke stack of the power station. This is a situation which is often met with in America where power stations are usually on river banks - as this one is in East London - but it is said to be the first time that measurements have disclosed it to be a factor in a South African town. - APCA

321. Helwig, H.L., and Gordon, C.L.: Colorimetric method for continuous recording analysis of atmospheric sulfur dioxide. Anal. Chem. 30:1810-1814 (Nov.) 1958.

Sulfur dioxide in the atmosphere can be determined continuously with automatic sampling and recording apparatus. The reaction of sulfurous acid with pararosanline hydrochloride and formaldehyde produces a red-violet color which is measured colorimetrically. At pH 1.5 this reagent is stable and exhibits good resistence to interferences at concentrations found in the atmosphere. Concentration limits for the instrument were established up to 5 ppm but these can be considerably extended or reduced. - PHEA

322. Himi, Y., and Ozaki, Y.: Chemical composition of deposited dust and smoke in Keihin industrial area and its suburban area. J. Chem. Soc. of Japan. Indust. Chem. Section 65:1901-1905 (Dec.) 1962.

This is report eight in a series of studies. In order to study the atmospheric pollution due to dust and to smoke in the Keihin industrial area, deposited dust and smoke has been analyzed at eight locations in the cities of Yokohama and Kawasaki. Determinations were made from this deposited material of changes in amounts of combustible material, of SiO_2, Fe_2O_3, Al_2O_3, CaO, MgO, MnO, and of water-soluble SO_4 and Cl, monthly for the period from May 1959 to April 1960. The average amounts (t./km.^{2}/month) of deposited material, in the industrial section, varied from 40 tons in May to 30 tons in July, then rose to 50 tons in September, dropped to a low of about 18 tons in February, and then rose again to 40 tons in March and April. In a non-industrial area these figures were about 10 to 12 tons for the months of May through September, rising to 20 tons in October, dropping to about eight tons in November, rising to 30 tons in December, dropping to 15 tons in February, rising again to 25 tons in March, and returning to about 12 tons in April. The main components of the deposited dust and smoke were found to be in the combustible material and SiO_2, in a non-industrial area, while in the industrial area it was SiO_2, Fe_2O_3, CaO, and water-soluble SO_4. It became clear that the main sources of the deposited dust and smoke were caused by the many factories in the area. Also domestic heating in the central section of Yokohama City had a very great effect on the atmospheric pollution of this area in the winter. - APCA

323. Hitchcock, L.B., and Marcus, H.G.: Some scientific aspects of the urban air pollution problem. Sc. Monthly 81:10-21, 1955.

The problem in Los Angeles is particularly treated in this discussion of urban air pollution. The analysis and instrumentation for each constituent in smog are reviewed. Control by means of reduction at the source with collection equipment, dilution of the source, as with tall stacks, and by planned allocation of land is discussed. The amounts of pollutants/100,000 registered automobiles in Los Angeles are estimated as CO, 280 tons/day; N oxides (as NO_2), 7.7; hydrocarbons, 44; SO_2, 1.8; aldehydes, 1.8; Pb, 0.05; oil droplets (aerosols), 1.3. Reduction of these combustion pollutants is discussed. The physiological effects of air pollution are not fully known but are thought to include cancer, irritation of the eyes and respiratory tract, noxious odors and tastes and reduced visibility. Data from industrial toxicology, studies of catastrophes and analyses of routine morbidity and mortality records have their limitations. The methods of the study recently begun by the University of Cincinnati College of Medicine are described. Economic loss in material goods, crop damage and poor combustion are discussed. The damage to plants from smog is described. - KB

324. Hochheiser, S., Burchett, N., and Dunsmore, H.J.: Air Pollution Measurements in Pittsburgh, January-February 1963. USDHEW, PHS, Div. of Air Pollution, Nov. 1963.

Pollution detected in this brief study at one location is of sufficient magnitude to justify further continuing studies of air quality in the Pittsburgh area. This work is necessary to provide air quality data for the determination of: (1) Extent of adverse effects of air pollutants, (2) trends in air quality, (3) effects of air pollution control regulations and other factors influencing pollutant emissions, and (4) plans for air resource management, including possible revision of emission regulation.

Pollution levels observed during this brief study reasonably represented the average winter in Pittsburgh. Because, however, no period of severe atmospheric stagnation was encountered, the present study has not indicated the unusually high pollution levels that would occur at such times. Tentative, preliminary conclusions

based on the limited data of this study are as follows:
1. Pollution due to particulate matter is high, as indicated by measurements of total suspended particulate matter, soiling index, visibility, and atmospheric turbidity.
2. Concentrations of sulfur dioxide, carbon monoxide, and aldehydes tend to be slightly greater than desirable.
3. Presence of photochemical smog was not demonstrated. Measurements of oxidant levels during late spring and summer may, however, cast a different light on this matter. Although oxidant measurements were very low in the current study, concentrations of hydrocarbons and nitrogen oxides were such that, at times of greater sunshine and lesser concentrations of sulfur dioxide, higher oxidant values could be expected. - Authors' Sum.

325. Hoffmann, A.: Pollution of the air with sulfur oxides during the foggy period in February 1959. Zeitschft. Bakteriol. 176:195-197 (Nov.) 1959.

Data contained in this article show that the SO_2 content of the ambient atmosphere can be increased through special meteorologic influences to such an extent as to be detrimental to the health of man.

326. Holmes, J.A., Franklin, E.C., and Gould, R.A.: A Report of the Selby Smelter Commission. USBMB 98, 1915, 528 pp.

An investigation in 1915 of the Selby Smelter situation gave the following conclusions. Prior to April 1, 1914, smoke, measured by the cumulative injury done to certain horses, was maintained in the "smoke zone." The installation of the bag house to the sintering machines of the smelter has abated this nuisance. Pb and As from the smoke was deposited on the soil of the "smoke zone" during the period of time included between the beginning of operations of the smelter and April 1, 1914, but the quantity of these metals so deposited was of no economic importance and did not poison the soil or in any way produce a loss or reduction of crops. The blackened appearance of many trees and plants in the "smoke zone" thought to be due to a deposit of Pb from the smelter smoke, was not attributed to such cause. SO_2 from the Selby smelter had not produced within the "smoke zone" a disagreeable or objectionable odor, or disagreeably or injuriously affected the throat and lungs of human beings or domestic animals living in the "smoke zone." Rare occurrences of these disagreeable circumstances were not thought to constitute a nuisance nor to prevent the peaceful enjoyment of life and property. The smelter had not maintained a nuisance with respect to economic damage to trees, vines, shrubs or growing crops or to the corrosion of wire screens or barbed wire in use within the "smoke zone." The mechanical devices used at the Selby smelter (at the time of the report) for the control of smoke and SO_2 were thought be be adequate and if operated within specifications would not maintain a nuisance with respect to the above.

In the course of the investigation the following experiments on the effect of SO_2 on man were carried out. 60 subjects, in a total of 85 experiments, were exposed to various concentrations of SO_2 ranging from 1-12 ppm. 32 were previously acquainted with the odor of SO_2 and 28 were not. The "trained" subjects level of perception was 3-4 ppm, while that of the "untrained" was 4-5 ppm.

The last part of the report gives more details on the investigation. - KB

327. Huber, T.E., Joseph, S.W., Knoblock, E., Redfearn, P.L., and Karakawa, J.A.: New environmental respiratory disease (Yokohama asthma). Arch. Indust. Hyg. & Occupat. Med. 10:399-408, 1954.

A type of asthma (Yokohama asthma) different from that occuring in the U.S. was first noted among the U.S. Army personnel in Yokohama in autumn, 1946. This disease was also found to occur among the indigenous Japanese, and in other parts of Japan that were in proximity to a harbor, usually surrounded by low hills, had sundry manufacturing facilities and the occurrence of "heavy smog" during the winter months. The clinical course of the disease is outlined. Biological studies in which pollen slides were collected monthly throughout Yokohama and intradermal testing with extracts of typical pollinating plants proved negative. Meteorological and pollution studies gave more positive results. Wind velocity, precipitation and inversions were found to bear a statistical relationship to the incidence of the respiratory disease entity. When the atmosphere was sampled for SO_2, N oxides, O_3, amount of dust and presence and amount of ether-soluble aerosols. a correlation between incidence of disease and air contaminants and smog formation was found and a significant correlation of the ether-soluble aerosols and dust with the incidence of the respiratory disease entity. This is demonstrated in the following table.

Contaminant	Smog-Free Days	Days of Smog Formation
Ether-soluble	0.011 mg./m.^{3}	0.081 mg./m.^{3}
Dust index	1.0	3.8
Sulfur dioxide	0.075 γ/l.	0.17 γ/l.
Ozone	0.081 γ/l.	0.17 γ/l.
Nitrogen oxides	0.26 γ/l.	0.50 γ/l. - KB

328. Igi, S.: On the amount of soot, dust, and sulfurous acid gas falling over northern Kyūshū. Fukuoka Acta Med. 54:266-273 (Feb.) 1963.

The amounts of dust and of sulfurous acid gas were measured through use of deposit gauges and of the lead peroxide method, respectively. Measurements were made monthly from April 1959 to May 1962 at 52 locations in industrial, commercial, and residential areas of northern Kyushu. The max. amount of deposited dust was 23.33 g./m.^{2} at Yahata, with an average amount of 20.17 g./m.^{2}, and showing a yearly decrease of about 6.5%. The max. amount of the sulfurous acid gas was 0.992 mg./100 cm.^{2}/day at Tobata, with an average amount of 0.719 mg./100 cm.^{2}/day, and showing a slight yearly increase. The ferric oxide content of the dust was 15-20%. The ratio of the soluble to the insoluble components of the dust depended on the substances contained in the dusts as well as on the amount of rainfall. - APCA

329. The Investigation of Atmospheric Pollution. Dept. Scientific Indust. Res. Warren Spring Lab. Stevenage, Herts, England. 1961. 143 pp.

Contents: Tables of observations for the year ended March 31, 1961. I. Smoke. II. Sulfur dioxide (volumetric method). III. Monthly observations of grit and dustfall by the British Standard deposit gauge. IV. Monthly observations by the lead dioxide instrument. Appendix. This is the 3rd collection of summary tables of observations. - APCA

330. Irving, R.J.: Tests on some impurities in the atmosphere of Leeds. Leeds Philosoph. Lit. Soc., Scientific Section, Proceedings 6:14-17, 1952.

Hourly measurements of soot and SO_2 were made on clear sunny days and foggy days in Leeds, both outside and inside the Brotherton Library of Leeds University during the period of Jan.-July, 1951. In outside air in fog there was 25 times as much soot as on a clear day; the actual concentration was not measured. SO_2 concentration on a clear day was as low as 0.05 ppm and on a very foggy day as high as 1.95 ppm. SO_2 maxima occurred between 5 p.m. and 11 p.m. and minima between 2 a.m. and 5 a.m. In a room not air conditioned results were similar, but filtering through gauze removed nearly all soot and SO_2, showing that much of the SO_2 was adsorbed on the soot particles. Tests at Sheffield showed ca. 0.7 ppm NO_2 and ca. 0.2 ppm SO_2. - KB

331. Itoo, K., Moriguchi, M., and Naruse, H.: Atmospheric pollution. I. Atmospheric sulfur dioxide concentration observed in Tokyo and its relation to meteorological elements. Papers Meteorol. & Geophys. (Japan) 6:19-25, 1955.

The concn. of SO_2 in the atm. is used as a basis for detg. atm. contamination. A dil. soln. of H_2O_2 is placed in a polystyrene impinger, and the air sample sucked in to produce the reaction $H_2O_2 + SO_2 = H_2SO_4$. The pH is measured by using a mixed soln. of brown cresol green and methyl red as an indicator. Although the total S compds. are measured by this method, the atm. contains far more SO_2 than other S compds. and the results obtained are considered to be a measure of the SO_2 in the air. The concn. in the center of Tokyo is 0.1 ppm and 0.01 ppm in the western outskirts, with the concn. less in Tokyo Bay. The SO_2 concn. is compared with wind direction, wind force, and atm. stability to obtain a correlation factor. - Authors' Abst.

332. Jacobs, M.B.: Concentration of sulfur-containing pollutants in a major urban area. In: Lodge, J.P., Jr. (Editor); Atmospheric Chemistry of Chlorine and Sulfur Compounds. Geophysical Monograph No. 3, Am. Geophysical Union. Natl. Acad. Sci., Natl. Research Council Publ. No. 652:81-87, 1959.

An examination of the data concerning a large urban area indicates that there are 5 major types of variation in the sulfur dioxide concentration in the atmosphere: (1) A seasonal variation high in winter and low in summer. (2) A diurnal variation with a secondary maximum in late afternoon. (3) A variation influenced by weather inversions with the highest concentration of pollution occurring with the more intense inversions starting at the surface in combination with low wind velocity. (4) A geographical variation as evidenced by decreasing concentrations of sulfur dioxide. (5) A variation which is dependent on the movement of specific air masses. The sulfur trioxide concentration in an urban area is generally low except for samples taken directly in the plume of industrial plants. The concentration of hydrogen sulfide in urban areas is generally low, of the order of ppb. except in localized areas adjacent to sewage disposal plants, analogous situations, or directly in the plume of an industrial plant. - APCA

333. Jacobs, M.B., Manoharan, A., and Goldwater, L.J.: Comparison of dust counts of indoor and outdoor air. Internat. J. Air & Water Poll. 6:205-213 (May-Aug.) 1962.

The dust count and particle size of suspended particulate matter of indoor and outdoor air was determined at 30 locations including homes, business offices, and offices and laboratories of Columbia Univ. A special adapter was developed so that a high vol. sampler could be used for sampling for dust counts by the membrane filter method. The counts for indoor air ranged from 1.47-53.4 and from 2.2-53.1 for the outdoor air. A statistical analysis of the results obtained for both the dust counts and the particle size distribution shows that there is no significant difference in these values for indoor as compared with outdoor dust. This is to be contrasted with the fact that there was a significant difference between the lower ash content of indoor as compared to that of outdoor dust. - APCA

334. Jacobs, M.B., Goldwater, L.J., and Fergany, A.: Comparison of suspended particulate matter of indoor and outdoor air. Internat. J. Air & Water Poll. 6:377-380 (Sept.-Oct.) 1962.

Suspended particulate matter was determined at 21 locations for indoor and outdoor atmospheres. The indoor samples ranged from 90-957 with an average of 284.8 $\mu g./m.^3$, but if 4 factory locations are omitted the indoor samples ranged from 90-462 with an average of 238.7 $\mu g./m.^3$. The outdoor samples ranged from 101-424 with an average of 243.6 $\mu g./m.^3$. These values are in agreement with other work in this field. There was some indication that carpeted rooms are dustier than uncarpeted rooms but statistical evaluation does not show a significant difference. - APCA

335. Jarvis, W.D., and Austin, L.G.: Routine surveys of atmospheric pollution by dust and sulfur dioxide around power stations of the central electricity authority. J. Inst. Fuel (London) 30:435-436 (Aug.) 1957.

The paper gives details of a number of atmospheric pollution surveys which have been carried out by the Central Electricity Authority to observe changes in the level of dust deposition and sulfur dioxide pollution in the neighborhood of modern power stations when the power stations were put into operation. The results so far obtained show that the increas in the rate of dust deposition within a radius of two miles of a power station is small. The average concentration of sulfur dioxide at ground level has shown a trend towards a small increase with increasing power station output, but changes which occurred in the background levels of sulfur dioxide concentrations during the period of the surveys do not allow a significant conclusion to be drawn. The results suggest that other methods of measuring small changes in the concentration of sulfur dioxide should be considered. - Authors' Abst.

336. Jedrzejowski, J.: Effects of a chemical plant on the environment. Gaz. Woda i Tech. Sanit. (Warsaw) 33:240-244, 1959.

The emission into the atmosphere of sulfur compounds discharged from a plant manufacturing artificial silk, is discussed on the basis of a study of the wind effects on distribution of sulfur components in the atmospheric air. Measurements were made at distances up to 10 km. from the plant chimney which was at a height of 100 m. Proper control of air pollution is considered to be possible only with the use of absorbers. Recommendations are given for calculating the control measures as well as formulas and procedures of calculation. - APCA

337. Jones, H.G., and Davies, J.T.: External dust deposition and sulfur emission. Proc. Air Pollution Meeting - Iron and Steel Inst. (London). Sept. 25-26, 1957. Special Rept. 61:16-23, 1958.

Methods of surveying dust and sulfur gas emissions in the locality of the works are described. The worst areas are within the works. Although there are considerable points of resemblance between the dust and SO_2 contours, they are not by any means identical. The differences are mainly traceable to known causes. Thirty sampling points were selected from the 64 used for the dust survey. During these tests, the samples were collected at weekly intervals and analyzed. A standard instrument has been developed for the estimation of sulfur gases which is known as the lead-peroxide instrument; this does not give results in absolute units but in a comparative measure it is used by local authorities and industrial organizations, throughout the country for routine testing. The measurements of the instrument are declared as mg. SO_3/day/cm.^{2} of lead peroxide. - APCA

338. Junge, C.E., and Werby, R.E.: The distribution of chloride, sodium, potassium, calcium, and sulfate in rain water over the United States. J. Meteorol. 15:417-425, 1958.

The distribution of yearly averages of the concentration of various inorganic ions in rain water over the United States is discussed. The major source of Cl^- is the ocean. The Cl^-Na^+ratio, however, is considerably less than that in sea water. It is very likely that this is caused by excess Na^+ from the soil. A similar distribution of excess material from the soil is observed with K^+. In contrast to Na^+ and K^+, which are rather uniformly distributed over the United States, Ca^{++} shows highest values over the Southwest, in agreement with the occurrence of dust storms.

Most of the SO_4--over the ocean originates from sea spray. The source of additional SO_4--is the land. Budget considerations indicate that about 30 per cent of this additional SO_4--on a global scale is due to human activities.

On the basis of the data presented, the average global residence time of SO_2 is estimated to be 40 days. This value is compared with available data on residence times of other constituents which are also primarily controlled by washout. - Authors' Abst.

339. Junge, C.E.: Sulfur in the atmosphere. J. Geophys. Research 65:227-237 (Jan.) 1960.

In unpolluted areas sulfur occurs primarily in 3 compounds, SO_4= in aerosols and SO_2 and H_2S as gas. Sources of SO_4= are the ocean, the soil, and the oxidation of the gaseous compounds. As measurements in polluted and unpolluted areas indicate, most of the H_2S seems to be natural. In unpolluted air in the northeastern part of the U.S., both gases have approx. equal concentrations. The chemistry of the conversion of these gases to SO_4= is discussed. It is concluded that industrial sulfur is removed from the atmosphere before it spreads to polar regions. This is consistent with estimates of the residence time of about 5 days for SO_2 and about 40 days for total sulfur. In view of the considerable amounts of industrial sulfur, it is possible that the global sulfur cycle is not closed and that most of the excess sulfur in river waters is of anthropogenic origin and will stay in the ocean.- APCA

340. Kanno, S., Fukui, S., Ikeda, H., and Ono, Y.: Atmospheric SO_2 concentrations observed in Keihin Industrial Center and their relation to meteorological elements. Internat. J. Air Poll. 1:234-240 (Jan.) 1959.

Atmospheric sulfur dioxide concentrations have been measured in one of the most important industrial areas of Japan, the Keihin manufacturing district between Tokyo and Yokohama. The SO_2 concentrations measured over a 1-yr. period did not exceed 0.19 parts per million. The data were correlated with daily, seasonal, climatological and meteorological data. - PHEA

341. Katz, M.: Photoelectric determination of atmospheric sulfur dioxide. Employing dilute starch-iodine solutions. Anal. Chem. 22:1040-1047, 1950.

Dilute solutions of starch-iodine have been found suitable for the continuous determination of low concentrations of sulfur dioxide in smelter areas where hydrogen sulfide is not likely to occur. The most effective concentration range of solution is from about $7\text{x}10^{-5}$N to $2\text{x}10^{-5}$N. The apparatus for the continous recording of sulfur dioxide consists of a Thomas analyzer, two gas bubblers containing 100 ml. of solution mounted in a block with a light source between them, and two photoelectric cells. The output current is passed through a standard resistance box and the voltage drop across the 0 to 500-ohm terminals is measured by a potentiometer with a scale range of 0 to 50 mv. The instrument has a range of less than 0.01 to 1.00 ppm or more, depending upon the size of the gas sample and the volume of solution used in the absorbers. It has been used for several seasons to determine the sulfur dioxide content of the air at a location in the Sudbury smelting district. Comparative tests of the iodine and hydrogen peroxide conductivity methods have been made with a portable apparatus on simultaneous samples of air in the path of the smelter fumes. The results indicate that a substantial fraction of the smelter smoke during a fumigation may consist of sulfur trioxide, sulfuric acid, or sulfate. - Author's Abst.

342. Katz, M.: Some aspects of the physical and chemical nature of air pollution. Air Pollution, WHO, Geneva, 1961, pp. 97-158.

Within recent years attention has been drawn to the complexity of the problem of air pollution in large urban centers. Although information is being rapidly acquired on many constituents of the contaminated atmosphere, the number of these contaminants is still unknown. The concentrations of most atmospheric contaminants are extremely low and the accurate determination of such substances taxes the ingenuity of the analytical chemist. All the activities of man, the biological processes of living matter and natural phenomena upon or below the surface of the earth result in the liberation of gases, vapors, dust and aerosols of suspended particulates to the atmosphere. The study of the nature, properties and behavior of these substances represents a challenge to the competence and skill of physicists, chemists and biologists. This informative chapter covering a broad area of the subject, has an exhaustive bibliography of about three pages.

343. Katz, M.: Air pollution in Canada -- current status report. Am. J. Pub. Health 53:173-184 (Feb.) 1963.

Air pollution problems have been multiplying steadily in Canada with the growth of population and industry. These problems are discussed in relation to the sources of air pollution and to atmospheric pollution levels in urban areas (dustfall, airborne particulates, composition of particulate pollution, sulfur dioxide, ozone or oxidants). Table 1 in the text gives the estimated rates of emission of contaminants (in pounds) from fuels, internal combustion engines, and incinerators per short ton of fuel burned. The information is given for solids, sulfur oxides, nitrogen oxides, and organic substances (including hydrocarbons, acids, and aldehydes.) Table 2 gives the mean monthly dustfall (tons/sq. mi./month) of various cities in Canada, the U.S., and the United Kingdom. Among the 8 Canadian cities these figures varied from a low of 21 tons in Vancouver in 1957 to a high of 60 in Montreal in 1960. New York had 85 tons in 1956 and Detroit 67 tons in the same year. In 1954 Glasgow had 73 tons, Birmingham 93 tons, Manchester 97 tons, and London 112 tons. In 1956 in Toronto and 1955 in Windsor these amounts varied from a high of 85.3 and 83.1 tons in industrial areas to 21.5 and 35.6 tons in suburban areas, respectively. Sulfur dioxide is a major contaminant in many Canadian urban and industrial areas. Since 1955, the presence of a photochemical smog injury has been noted in the "weather fleck" damage to tobacco grown in southern Ontario along the northern shore of Lake Erie. Canadian research activities, including those undertaken by the Federal government, as well as by the provincial or municipal governments or by industrial organizations, are discussed. - APCA

344. Kruglikova, Ts.P., and Efimova, V.K.: Atmospheric sulfur gas as a source of air pollution in residential dwellings. Gigiena i Sanit. 23:75-83 (March) 1958.

Prolonged action of sulfur gases, even at a concentration below 1 mg./m.^{3} can cause damage to men, plants, and metals. An investigation was carried out (1) in the vicinity of a chemical plant near an oil refinery, both emitting sulfur gases, and (2) in 2 districts removed from industrial plants, one of which was a narrow, poorly ventilated, densely populated street of old houses containing numerous stoves. The air was tested outside and inside the houses, in the summer and winter of 1955. The results show that the concentration of sulfur gas inside the houses depends directly on the outside concentration. In the industrial zone, at a distance of 200-300 m. from the plants, the SO_2 concentrations of the outside atmosphere were 0.8 to 2.7 mg./m.^{3} in winter, and 0.25 to 2.2 mg./m.^{3} in summer; inside the houses they were 0.25 to 0.8 and 0. to 0.9 mg./m.^{3} respectively. The percentage of positive tests in the houses was 72-73%. Within an 800-1000 m. radius from the plants, the max. concentration outside was 1.6 mg./m.^{3}, and inside the houses 0.7 mg./m.^{3}. It appears that sulfur gases penetrate into the houses even when the windows are closed, absence of aeration contributing only to their accumulation. In the one non-industrial zone (with the narrow streets), the max. SO_2 concentration in some cases attained a level close to that of the industrial zone -- up to 1.9 mg./m.^{3} outside, and 1.0 mg./m.^{3} inside the houses in winter, and 0 to 0.25 mg./m.^{3} both outside and inside in summer. In the other non-industrial district the concentrations were less, but showed the same dependence of the inside atmosphere upon the air outside. The SO_2 concentration in the residential district, both outside and inside the houses, depended entirely on the seasonal heating of stoves. In a still farther removed area, the max. concentration was found to be 0.3 to 0.4 mg./m.^{3}. - APCA

345. Larsen, R.I.: Parameters of aerometric measurements for air pollution research. Am. Indust. Hyg. A. J. 22:97-101 (April) 1961.

A brief description of a continuous gas sampling network is presented in which a number of air pollutants is to be measured in six United States cities beginning about mid-1961. Parameters are presented of aerometric measurements from a two-year study of sulfur dioxide in Louisville, Kentucky, to be related to health and other effects. Six equations are developed to depict the frequency, duration, and air pollution dosage. - Author's Abst.

346. Larsen, R.I., Stalker, W.W., and Claydon, C.R.: The radial distribution of sulfur dioxide source strength and concentration in Nashville. J. APCA 11:529-534 (Nov.) 1961.

The U.S.P.H.S. Division of Air Pollution and the School of Medicine of Vanderbilt University conducted an air pollution study in Nashville in 1958-1959. Sulfur dioxide emission and sulfation data were studied to determine their interrelation and variation as a function of radial distance from the center of town. Both sets of data appeared to fit a Gaussian or "normal" curve. Thus the only values needed to describe the radial distribution of sulfation in Nashville for a given season are: (1) the concentration at the center of town, (2) the background concentration outside of town, and (3) the "standard radial deviation," a parameter analogous to standard deviation in the "normal" equation. The standard radial deviation ranged from 0.2 of the radius of Nashville in the summer to 0.4 in the winter. The fall, spring, and annual values were 0.3. Thus sulfation may be pictured as a bell-shaped dome over Nashville, superimposed on a background value for the surrounding area.

The fall, spring, and annual sulfation values were of comparable magnitude. Winter sulfation at the center of Nashville (17 g of SO_3/sq.cm./day) was three times as great as the annual value; summer sulfation was one-fourth of the annual value. For each of the seasons and the year, sulfation at the center of Nashville was approximately seven times the non-urban values. A computer-solved mathematical model relating source strength to sulfation indicates a fairly good fit to the study results when sulfation is considered as being inversely proportional to the square of distance between source and receptor. - PHEA

347. Larson, T.E., and Hettick, I.: Mineral composition of rainwater. Tellus 8:191-201 (May) 1956.

Analyses of 62 rainwater samples collected at the University of Illinois Airport near Savoy, Ill., showed that on the basis of equivalent concentrations, the chloride is equal to the sum of sodium and potassium. Sodium was three times the potassium. Calcium plus magnesium was 10 times the chloride and equal to the sum of the bicarbonate and sulfate. The sulfate was equal to twice the sum of ammonium and nitrate. These results indicate salt from sea mist to constitute a negligible proportion of the mineral content. They also indicate the presence of air pollution by the combustion of fuel.

348. Lawrence, E.N.: Atmospheric pollution (sulfur dioxide) in hilly terrain. Internat. J. Air & Water Poll. 6:5-26 (Jan.-Feb.) 1962.

The effects of wind on measurements of pollution by the lead dioxide method are discussed. A formula which makes some allowance for wind speed (that is, a run-of-wind through the lead dioxide equipment) is suggested for the conversion of lead dioxide readings into concentrations of sulfur dioxide. This formula is used to study surface pollution profiles in a hilly rural area surrounded by distant industrial sources. A tendency for a maximum concentration is found to occur at an intermediate level between the valley bottom and the surrounding hilltops but there is evidence also of a pollution lapse profile. It is suggested that pollution inversion and lapse profiles are associated, respectively, with over-barrier transport and valley infiltration from sources below. Excluding seasonal variation in source strengths, concentrations depend mainly on atmospheric stability; shelter from wind in hilly terrain probably emphasizes this relationship.-PHEA

349. Lawther, P.J., and Waller, R.E.: Atmospheric pollution and lung cancer. Trans. A. Indust. M. Officers (London) 9:5-8 (April) 1959.

Deaths from lung cancer in England and Wales have increased steadily from 3432 in 1936 to 8110 in 1946, and to 18186 in 1956. Reasons for suspecting that air pollution may cause cancer are that urban air contains substances, especially 3,4-benzpyrene, known to be carcinogenic, and the disease occurs more often in towns than in the country. There are other carcinogenic substances in town air, among them 1,2-benzanthracene; 1,12-benzpyrene; benzene; chrysene; epoxides; and arsenic. More carcinogens in the air undoubtedly await identification but, for the present 3,4-benzpyrene claims attention because of its ubiquity and known potency. Extrapolation from animal experiments is dangerous since it cannot be assumed that the substance necessarily causes lung cancer in man. A high urban to rural ratio of lung cancer incidence in Norway has been shown despite a very low level of air pollution. There is direct evidence that living in large towns can provide an additional risk of lung cancer for non-smokers. The diesel engine is a new source of air pollution but it has not been used long enough to have been responsible for the increased incidence of lung cancer. Investigations in the London Transport bus garages showed that on a winter's night the concentration of 3,4-benzpyrene, was much the same inside as outside. On a fine clear night in early summer it was found that the buses could be adding some benzpyrene to the air but less than 1/10 of that found in the outside air in winter. Medical examinations of the workers failed to show any excessive incidence of lung cancer such as would be expected if diesel fumes were a serious contributory factor. The authors conclude that cigarette smoking is a factor of overwhelming importance in the matter of lung cancer and that air pollution plays a role of minor significance. - APCA

350. Leavitt, J.M.: Meteorological considerations in air quality planning. J. APCA 10:246-250 (June) 1960.

City planners are now turning to land use programs to eliminate potential community air pollution problems. The new city of Stalingrad is a good example. The city was laid out to preserve the air quality of the residential, recreational and park areas. It is divided into two sections, aligned almost perpendicularly to the prevailing wind direction. The zones comprising the more favorable windward side include the residential, park, and recreational areas, and the zones comprising the less favorable leeward side include the industrial, railroad, and green-belt highway areas. However, urban planning in the United States requires a more sophisticated treatment of air quality features than in the case of Stalingrad where wind direction alone was the dominant design criterion.

Using air flow and weather conditions as normally experienced, the application of meteorological considerations to community land-use planning consists of two phases. The first involves quantitative estimates of pollution patterns from proposed districts marked for industrial development, and the second involves the evaluation of source-site suitability in terms of the functional characteristics of the receptor areas.

The method is demonstrated with Tulsa, Oklahoma, using temperature gradient data from a 215 ft. radio tower on the University of Tulsa campus and concurrent wind data from the Tulsa Weather Bureau Airport Station for a three month period. In the first phase radial diagrams were constructed for each of six categories of meteorological condition to show resultant surface concentrations obtained by multiplying computed concentrations at various distances by the appropriate wind direction frequency distribution. Then the concentrations for each of the six classifications were added and superimposed on maps of three mile radial receptor areas. In the second phase, topography is briefly considered and the land-use of four city districts is discussed. Two of the districts favor more marked industrial development whereas such development in the other two areas is problematical. - PHEA

351. Leff, S.: London's dirty air. M. World (London) 89:362-366 (Oct.) 1958.

During the intense fog of December 1952, those persons with either chest or heart troubles were the most seriously affected and many of the 4000 deaths occurred within that group. Other persons came to practitioners with complaints of sore throats, coughs, and running noses. Another less severe fog occurred in London in 1956 resulting in about 1000 deaths. Studies have revealed that during a fog it is safer to live away from power stations, gas works, and railway sidings. During a fog most of the solid matter in the vicinity such an installation is thrown down within a distance of $\frac{1}{4}$ mile. Other serious sources of pollution are the locomotives and the motor vehicles, both petrol and diesel. The petrol engine contributes chiefly carbon monoxide, hydrocarbons, oxides of nitrogen, and aldehydes; the diesel engine, more soot and sulfur dioxide. Both give off 3,4-benzpyrene. Experiments have shown that carbon monoxide may have an effect on a pedestrian at a concentration of 50 ppm. after an exposure of 4-8 hr. There is a headache and some shortness of breath after an exposure of 100 ppm. for 2-3 hr. The average in street samples was 15 ppm., with up to 50 ppm. in areas of heavy traffic and up to 80 ppm. in some areas during fog. Vehicles with faulty exhaust systems may add up to 300 ppm. A concentration of these figures could be anticipated during a severe fog if the concentration of carbon monoxide should rise to between 5 and 10 times the usual level as the smoke and sulfur dioxide levels did during the earlier London fog. A standard of 250 ppm. has been fixed for the vehicular tunnels of London. Samples taken regularly indicated that in 1 tunnel the max. reached 460 ppm. or almost 50 times as high as ground level readings of Oxford St. In 2 areas of London where the figures for smoke and sulfur dioxide were low and few of the inhabitants had lived in London all their lives, there were fewer than average deaths from bronchitis; in 2 areas of heavy pollution, mortality from bronchitis in men was well over twice the average. - APCA

352. Lenshin, V.T.: Sulfur anhydride in the atmosphere of Leningrad. In: Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U.S. Dept. of Agriculture, Office of Tech. Services, Washington, D.C., May 1960, Vol. 3, pp. 200-204.

The present article represents an attempt to analyze the problem of the connection between the concentration of sulfur dioxide (sulfur anhydride) in the air and certain meteorological factors. The work is based on a study by V.N. Gus'kova in Leningrad published in 1951, which utilized the results of 313 determinations of SO_2 made during 130 experimental days (between Feb. 1947 and Feb. 1948) in 4 different regions of that city. The average yearly temperature computed over many yrs. in the city of Leningrad is 4.2°C. According to the calculations of the current study, this value of t corresponds to a SO_2 concentration of 0.062-0.065 mg./m.^{3}, which is equal to the average monthly concentration of SO_2 in the month of October. The computed half-yearly indices of SO_2 concentration for Leningrad in 1947 and 1948 respectively were: for the warm period, 0.034 and 0.033 mg./m.^{3}; for the cold period, 0.179 and 0.15 mg./m.^{3}. As described in the earlier work, an inverse correlation was found to be apparent between the average monthly concentration of SO_2 and the average monthly ambient temperature. However, the assertion that the average monthly concentration of SO_2 in the areas under discussion depends chiefly on the time of the year whether warm (April 15- Nov. 15) or cold (Nov. 15-April 15), is not completely precise. The principal causes of seasonal variations in the SO_2 concentration in the air of Leningrad, in addition to changes in amount of consumed mineral fuel for heating during the cold period, are seasonal changes in the vertical temperature gradient (γ) which are clearly represented in the inverse correlation between the concentration of SO_2 and the air temperature when the year-round measurements of SO_2 exclude the influence of wind on concentration. This factor, which depends exclusively on meteorological conditions, is the dominant one not only for Leningrad but also for a number of the larger industrial centers - Khar'kov, Rostov-on-Don, and others--where surface radiation inversions are seen even more frequently than in Leningrad, are more clearly expressed. - APCA

353. Leonard, A.G.G., McVerry, B.P., and Crowley, D.: Atmospheric pollution in Dublin during the year 1939. Sc. Proc. Roy. Dublin Soc. 22:257 1940.

A report on air contaminants, listing the various types, is presented for the year 1939. Graphs indicate monthly levels of suspended impurities. Other measurements include sulfur dioxide and sunlight. Pollution by suspended matter is compared with deaths from respiratory diseases. "It is a well-established fact that the death rate from respiratory diseases is higher in cities than in rural areas, and in large cities, such as Manchester, periods of fog are followed by a rise in the death rates from such diseases. City fogs are due to an increase in the amount of suspended matter in the air."

A graph comparing the intensity of air pollution each week with the weekly total of deaths from respiratory diseases in Dublin shows markedly similar curves. It is concluded that any pronounced rise in pollution during the winter is followed shortly by a rise in the death rate.

"It is to be remembered that high pollution by suspended impurity is accompanied by corresponding high pollution by sulfur dioxide, and also that periods of high pollution by these quantities are always periods of low temperature."

A comparison of death rates of Dublin county and the city are given, showing a marked increase in the city, due allegedly to air pollution. - BAAP

354. Levine, B.S. (translator): Ryazanov, V.A. (editor): Limits of Allowable Concentrations of Atmospheric Pollutants. U.S. Department of Commerce, Office of Technical Services, Washington, D.C., Book 1, 1952.

Basic principles of hygienic standardization of atmospheric air pollutants. V.A. Ryazanov. Limits of allowable concentrations of sulfurous gas (sulfur dioxide) in the atmosphere of populated areas. V.A. Ryazanov. Limits of allowable concentrations of non-toxic dust in atmospheric air of inhabited localities. M.S. Gol'dberg. Allowable concentration of oxides of nitrogen in atmospheric air. P.D. Vinokurov and S.N. Kosourov. Limits of allowable concentrations of hydrogen sulfide in the atmospheric air of inhabited localities. B.P. Gurinov. Limits of allowable concentrations of carbon bisulfide in the air of inhabited localities. K.C. Beryushev. Limits of allowable concentrations of carbon monoxide in atmospheric air. Z.G. Vollson. Limits of allowable concentrations of lead in the air of residential regions. N.M. Tomson. The limit of allowable concentration of mercury vapors in the air of inhabited areas. R.G. Leites. Limits of allowable concentrations of chlorine in atmospheric air. E.K. Ugryumova-Sapozhnikova. Methods for the collection and study of air samples in the control of atmospheric cleanliness in inhabited localities. V.A. Ryazanov, et al. Supplement No. 1: A critical review of Book No. 1, A.I. Shafir. Bibliography. - APCA

355. Levine, B.S. (translator): Ryazanov, V.A. (editor): Limits of Allowable Concentrations of Atmospheric Pollutants. U.S. Department of Commerce, Office of Technical Services, Washington, D.C., Book 2, 1955.

The second stage of the work of the committee for the determination of limits of allowable concentrations of atmospheric pollutions. V.A. Ryazanov. Limits of allowable concentrations of oxides of phosphorus in the atmosphere. A.S. Arkhipov. Limits of allowable concentrations of fluorine compounds in the air of inhabited localities. S.V. Miller. Limits of allowable concentrations of manganese and its compounds in the atmospheric air of inhabited localities. V.A. Litkens. Limits of allowable concentrations of sulfuric acid in the air of inhabited localities. V.A. Ryazanov. Limits of allowable concentration of arsenic compounds in the atmospheric air of inhabited localities. B.P. Gurinov. Limits of allowable concentration of phenol in the atmospheric air of inhabited localities. K.G. Beryushev. Limits of allowable concentrations of benzene vapors in the air of inhabited localities. S.N. Kosourov. Limits of allowable concentrations of benzine (gasoline) vapors in the air of inhabited localities. S.N. Kosourov. The correlation between clarity of atmosphere and air dust content. B.V. Rikhter. Methods for the determination of atmospheric pollutants. M.V. Alekseeva. Bibliography. Supplements. - APCA

356. Levine, B.S. (translator): Ryazanov, V.A. (editor): Limits of Allowable Concentrations of Atmospheric Pollutants. U.S. Department of Commerce, Office of Technical Services, Washington, D.C., Book 3, 1957.

New data forming the experimental basis for limits of allowable concentrations of atmospheric pollutants. V.A. Ryazanov. The determination of the limit of allowable concentration of sulfuric acid in atmospheric air. K.A. Bushtueva. Hygienic evaluation of pollution of atmospheric air of a large city with sulfur dioxide. F.I. Dubrovskaya. Basic principles for the determination of limits of allowable concentrations of hydrogen sulfide in atmospheric air. R.A. Loginova. The determination of limits of allowable concentrations of benzene in atmospheric air. Yu. V. Norvikov. Atmospheric air pollution with fluorine as the cause of fluorosis in children of inhabited localities. M.S. Sadilova. Methods for the experimental determination of limits of allowable concentrations of atmospheric air pollutants. V.A. Ryazanov, et al. New methods for the study of atmospheric air. M.B. Alekseeva. Appendix I and II. - APCA

357. Levine, B.S. (translator): Ryazanov, V.A. (editor): Limits of Allowable Concentrations of Atmospheric Pollutants. U.S. Department of Commerce, Office of Technical Services, Washington, D.C., Book 4, 1960.

Experimental investigations. Limits of allowable lead concentration in the air of inhabited localities. M.I. Gusev. Basic principles for the determination of allowable chlorine concentration in the atmosphere of inhabited localities. M.T. Takhirov. Materials for the determination of limits of allowable concentrations of dichlorethane in atmospheric air. M.K. Borisova. Basic investigations for the determination of the limit of allowable acrolein concentration in atmospheric air. M.M. Plotnikova. Threshold reflex effect of SO_2 and sulfuric acid aerosol simultaneously present in the air. K.A. Bushtueva. Methods. Aspiration method for the determination of radioactive aerosols in the atmospheric air and results of investigations. V.F. Oreshko, A.Z. Belousov, Iu.V. Novikov and B.I. Polivoda. Use of the plethysmographic method in basic studies for the determination of allowable atmospheric air pollutant concentration. M.K. Borisova. Spectrophotometric determinations of coproporphyrin eliminated by the urine. M.I. Gusev and Iu.K. Smirnov. Automatic 24-hr. aspirator for the collection of atmospheric air samples. M.A. Pinigin. Methods for the determination of atmospheric air pollution. M.V. Alekseeva. - APCA

358. Levine, B.S. (translator): Ryazanov, V.A. (editor): Limits of Allowable Concentrations of Atmospheric Pollutants. U.S. Department of Commerce, Office of Technical Services, Washington, D.C., Book 5, 1962.

Like the previous 4 books already published under this title, book 5 contains reports of investigations conducted under the directions of a special Committee of the State Sanitary Inspectorate of the U.S.S.R. Ministry of Health. Unlike the other books of the Committee, book 5 contains no description of chemical analytical procedures, since all procedures approved and recommended by the Committee have been incorporated by M.V. Alekseeva in the second edition of her book entitled "Determination of Atmospheric Pollutants" which is about ready for distribution. It is also mentioned in the foreword that in a paper by N.A. Liubimov there is a description of a continuous 24-hr. gas analyzer for the determination of SO_2 in atmospheric air. And that this is the 1st Soviet-constructed gas analyzer of high sensitivity used in atmospheric air investigations. The table of contents lists the following paper: Investigations in the field of limits of allowable concentrations of atmospheric pollutants during 1958-1959. V.A. Ryazanov. New studies on the effect of low concentrations on the human organism. M.I. Gusev. Limit of allowable concentration of lead sulfide in atmospheric air. O.P. Shalamberidze. Basic data for the hygienic determination of limits of allowable mercury vapor concentration in atmospheric air. V.N. Kurnosov. Atmospheric air pollution with gasoline vapor and its limit of allowable concentration. N.F. Izmerov. Basic experimental information for the determination of the limit of allowable methanol concentration in atmospheric air. Chzhao Chzhen-tsi. Basic experimental information for the determination of the limit of allowable chloroprene concentration in atmospheric air. A.V. Mnatsakanian. New studies of the effect of sulfur dioxide and of sulfuric acid aerosol on reflex activity of man. K.A. Bushtueva. Experimental studies on the effect of low oxides of sulfur concentrations on the animal organism. K.A. Bushtueva. Basic data for the determination of limits of allowable concentration of acetates in atmospheric air. V.A. Gofmekler. A nephelometer with an automatic 24-hr. device for continuous recording of sulfur dioxide concentrations in atmospheric air. N.A. Liubimov. Also there are 3 reports which originally appeared in Gigiena i Sanit. (Moscow): Air evaluation in industrial premises in the presence of several pollutants. A.G. Aver'ianov. Air evaluation in industrial premises in the presence of several harmful compounds in the air. P.I. Bogatkov and Iu. G. Nefedov. Hygienic evaluation of surrounding air containing several harmful pollutants. V.V. Kustov and L.A. Tiunov. - APCA

359. Lewis, R., Gilkeson, M.M., and McCaldin, R.O.: Air pollution and New Orleans asthma. Preliminary Report. Pub. Health Rep. 77:947-954 (Nov.) 1962.

A series of investigations was carried out by Tulane Univ. under contract with the Public Health Serv. to determine the source and nature of air contaminants which produce asthma in New Orleans, La. Daily admissions to Charity Hospital emergency clinic for treatment of asthma ranged from 3 to 200 during the period 1953-60. The modal number of daily admissions was 25. Analysis of data from the clinic which pertained to asthma, and analysis of data from the U.S. Weather Bur. station at Moissant Airport, disclosed that asthma outbreaks were most commonly associated with winds of low speed from south and southwest. Occasional outbreaks occurred with wind from the north and northeast. A number of air pollutants were collected and analyzed and their prevalence was compared with the prevalence of asthma outbreaks. A statistically significant relationship was found between the daily asthma admissions at Charity Hospital emergency clinic and the prevalence of 1 air pollutant, a poor-combustion particle with associated silica. No relationship was shown between concentrations of other pollutants and the number of reported asthma attacks. It would appear either that the poor-combustion particle with associated silica produces asthma or that it travels in consort with asthma-producing agents. This particle could arise from combustion processes in which siliceous material is present and burning is inefficient. All possible sources of this material were not examined; however, samples taken at 1 dump in the summer of 1961 revealed large quantities of this particle. In order to carry this investigation to conclusion, the emissions from the dumps will be analyzed to identify the specific materials involved, and these materials will be evaluated with respect to their allergenic properties. Continued research is now underway. An added note states that in an episode in New Orleans in Oct. 1962, it was reported in the national press that more than 300 persons sought treatment and 9 asthmatics died during 1 week. - APCA

360. Lodge, J.P., Jr.: Some observations of chloride-sulfate relationships in the atmosphere and in precipitation, in Weikman, H. (editor): Physics of Precipitation. Geophysical Monograph No. 5, Pub. No. 746, Am. Geophysical Union, National Acad. Sc. -- National Res. Council, Waverly Press, Inc., Baltimore, Md. 1960, pp. 252-256.

A series of measurements, including the determination of chloride and sulfate in particulate matter, were made at a U.S. Coast Guard weather ship midway between Honolulu and San Francisco. Even in this extremely isolated location, the sulfate concentration frequently exceeded the chloride. In the light of this finding, chloride-sulfate relationships were examined for a number of other remote stations; published data in the literature have also been studied. The chloride-sulfate regression lines were found to vary markedly in slope and intercept. There appears to be a definite relationship between chloride and sulfate concentrations; however, the nature of the relationship varies markedly with location. An interpretation is offered, based upon a three-source model. - Author's Abst.

361. Loginova, R.A.: Data on the basis of which to establish the permissible limit of hydrogen sulfide concentration in the atmospheric air. Pred. Dop. Kontzen. Atmos. Zag. (Moskva) 3:63-64, 1957.

The paper deals with the experimental check-up and the more accurate definition of the threshold of perception of the smell of hydrogen sulfide, and with the establishment of the permissible single-dose maximum concentration of hydrogen sulfide in the atmospheric air. In conformity with the suggestion of the commission for permissible limits of concentrations of atmospheric pollution regarding the standardization, by means of the most sensitive indicator, of the content of polluting substances in the atmospheric air, the author determined the smelling threshold for hydrogen sulfide. A special laboratory set-up is proposed. An examination of 670 people revealed that, taking into account individual variations of sensitivity, 0.040 mg./cu.m. should be taken as the olfactory threshold for pure hydrogen sulfide. In addition, the effect of the hydrogen sulfide pollution of the air on the health and the sanitary living conditions of the population in the oil industry region between the Volga River and the Ural Mountains was studied. In the oil gases of that region, hydrogen sulfide is present up to 5-6%, even 10%. By an examination of 1,247 samples, considerable hydrogen sulfide pollution of the atmospheric air in the vicinity of the oil plants was found. From 491 questioned inhabitants living near one of the oil plants, 73% indicated the presence of the smell of gas in the air, and some of them complained of headaches, loss of appetite, and nausea. Similar complaints were found in a number of other localities. It was found that the smelling threshold for hydrogen sulfide as a component of oil gas is lower than that for pure hydrogen sulfide, and is between 0.01-0.03 mg./cu.m. The hydrogen sulfide pollution of the air in concentration below the accepted permissible limit of single-dose maximum concentration has an unfavorable effect on the feeling of well-being of the population. In the oil industry, hydrogen sulfide does not act alone, but in conjunction with other components of the natural oil gas; therefore, stricter demands have to be made in these districts as to the hydrogen sulfide contents of the atmospheric air. On the basis of these data, the author suggests to accept 0.03 mg./cu.m. as the maximum single-dose concentration for pure hydrogen sulfide, and 0.015 mg./cu.m. for hydrogen sulfide contained in the natural oil gas. - PHEA

362. London Fog. Lancet 1:439 (Feb. 23) 1963.

The county medical officer of health reported on the fog episode of Dec. 3-7, 1962, that 340 deaths were attributable to the fog, one third in the age group 45 to 69, and two thirds in the age group 70 and above. Compared with the 1952 incident there was less smoke, but sulfur dioxide concentrations were comparable with those of 1952. Although elderly persons are affected by smoky fogs, the sulfurous fogs of 1952 and 1962 affected also persons in the middle age groups. The low excess mortality is attributed not only to smoke control but also to wide publicity.

363. Lucas, D.H.: The atmospheric pollution of cities. Internat. J. Air Poll. 1:71-86 (Oct.) 1958.

The paper assesses the pollution levels of sulfur dioxide (and smoke) likely to be produced by the thousands of domestic fires in large cities. It shows that the major part of the pollution measured in large cities can be attributed to domestic fires even though the concentrations produced by a single fire are negligible.

An approximate formula is given so that city concentrations can be estimated if the rate of emission, the wind speed, and the size of the city are specified.

The worst pollution occurs about a mile downwind of the center of the city and pollution levels decrease extremely rapidly outside the city boundary, particularly when averaged over a range of wind directions. When the atmosphere is stable, ground-level concentrations tend to be high. The effect of fog is complex and uncertain. It appears likely, however, that SO_2 (and smoke) is removed by the fog and that the "time constant" is between 8 and 20 hr. - Author's Abst.

364. Lucas, D.H., Moore, D.J., and Spurr, G.: The rise of hot plumes from chimneys. Internat. J. Air & Water Poll. 7:473-500 (Aug.) 1963.

Measurements of plume rise at two Central Electricity Generating Board power stations have led to the formula

$$z_{max} = \frac{aQ^{\frac{1}{4}}}{U}$$

where a is 4900 for one station and 6200 for the other. (U = wind speed in ft/sec; Q = heat emission in MW z_{max} = plume rise in ft.)

A number of other publications of measured results have been considered and shown to be in reasonable agreement with the formula, provided a correction is applied for the distance at which maximum plume height is measured. The results do not agree with any previously published theoretical formula, but the theory of Priestley has been considered and is shown to be capable of reconciliation with the measured results. It is shown that measured results of plume rise can be reconciled with measured results of ground-level concentration, provided there is a proper discussion of the relationship between short-term and long-term measurements. Further study is needed to establish the reasons for the variation in the experimental values of a. - Authors' Abst.

365. Mage, J., and Batta, G.: Expert findings on the cause of the accidents that occurred in the Meuse Valley during the fogs of December 1930. Chimie et industrie 27:961 (April) 1932.

This report covers many phases of the Meuse Valley incident, including a section on the medical findings.

It appears that most of the ill persons were elderly and included a large number of asthmatics and cardiacs. There was some illness among healthy adults and children. Deaths were generally ascribed to cardiac failure. Autopsies showed a diffuse congestion of tracheal mucosa and large bronchi. Soot particles were observed free in the pulmonary alveoli.

There is a section which discusses the possible causative agent in the episode and the conclusion is reached that it was most likely compounds of sulfur, especially sulfur dioxide. - BAAP

366. Marsh, A.: A review of the domestic smoke problem. Smokeless Air, Summer 1962, pp. 272-278.

The domestic chimney is now the most serious single source of air pollution in Great Britain, and its harmful consequences are now known to be greater than had previously been realized. The problem is being solved, but at a slower pace than is possible and desirable, and the necessary action is lagging behind the practical progress that could be made. Solid smokeless fuel supplies are satisfactory but future progress can best be ensured by encouraging a greater diversity of use of gas, electricity and oil. The criticisms and difficulties that have been encountered in developing the smoke control area programme are small in comparison with the success that this has attained as shown by its effectiveness in what is now approaching a million homes. But a great deal more education on the importance of clean air is needed among both the general public and a not inconsiderable number of local authorities.

To the latter one cannot do better than repeat the admonition that ends the Minister's Circular of January 30, which asks local authorities in the black areas who have not yet prepared programmes "to consider again most carefully whether their present policy is consistent with the health and well-being of their communities."

367. Marsh, A.: The December smog. A first Survey. J. APCA 13:384-387 (Aug.) 1963; and Smokeless Air, Spring, 1963.

The fog which developed on Monday, December 3, 1962, and did not clear unti the following Friday, affected many parts of Britain, varying considerably in different places and at different times. The area most affected was the South-East of England, and as in 1952 the most dense and persistent fog was over London and the Thames Valley. The effects in certain other cities are noted separately, and the following report relates only to London.

The fog, which rapidly became smog, has been widely compared to the 1952 episode, which occurred between December 4 and 9. On that occasion the fog lasted rather longer and appears to have been, generally, somewhat denser and more persistent. In considering the effects upon health the fact that the fog duration was shorter in 1962 than in 1952 is less material than might appear, for in the earlier episode most of the deaths and illness occurred on the first and second days.

The depth of the fog, or height of the inversion, was similar on both occasions, namely, 300 to 400 feet, and as the photograph above shows, high points were at times above the fog and in bright sunshine. Temperatures in low-lying areas in 1962 were a little lower (about $1^{o}C$) than in 1952.

The full records and other data are not available at this time. - Author's Abst.

368. McCabe, L.C.: Atmospheric pollution. Indust. Chem. 43:83A (Jan.) 1951.

This short paper describes a study made in St. Louis, Mo., where use of low-sulfur fuels has helped to reduce sulfur dioxide concentrations in downtown St. Louis by as much as 83% in winter and 73% in summer.

The importance of systematic sampling in the initial evaluation of the air pollution problem and in measuring the effectiveness of remedial measures once they are in operation are pointed out.

369. McMahan, J.F.: City air searched for sulfur fumes. Science 89:61, 1939.

A 15-month survey was conducted to determine average amounts of sulfur gases in the air over 25 American cities. Five metropolitan districts received more extensive study. Measurements were taken at all hours of the day and night and during all seasons of the year. Results varied from a high of 0.128 parts per million in St. Louis to 0.009 parts per million in Washington, D.C. It was concluded the amounts (even the maximum reading 2.266 parts per million found in St. Louis) were insufficient to cause harmful physiological effects. Home fires using high sulfur content coal, which produced sulfur gases, were found to be big contributors to the pollution. Concentrations were higher in the cold seasons or "heating seasons." A close relationship existed between wind velocity and pollution, the highest concentration being found on foggy nights. - BAAP

370. Meade, P.J., and Pasquill, F.: A study of the average distribution of pollution around Staythorpe. Internat. J. Air Poll. 1:60-70 (Oct.) 1958.

An examination has been made of the average distribution of sulfur pollution around Staythorpe power station in relation to sulfur output and wind statistics during the period November, 1951 to September, 1954.

Basic data, consisting of the seasonal averages of sulfur pollution as measured at fourteen observing sites at various distances and in different directions from the power station, were available as a result of a survey instigated by the Atmospheric Pollution Research Committee.

If the measurements obtained at each observing site depend on the output of sulfur dioxide from the power station, then they should also reflect the wind distribution in the area. The importance of wind direction is self-evident, but wind speed must also be taken into account since, for a constant distance from an elevated source, concentrations are inversely proportional to wind speed. The fact that the individual observing sites were at varying distances from the power station was another factor that had to be considered. This is so because the ground level concentration downwind of an elevated source is small near the source, increases to a maximum some distance away and then falls off steadily as one moves still further from the source. This important factor was dealt with by studying the pattern of pollution in the area and then estimating concentrations along arcs of a circle of specified radius about the power station.

The data for winter and summer half-years separately are shown to support a relation, which follows from conventional treatment of diffusion from a point source, of the form

$$p = a + b \frac{f(0)S}{u}$$

In this relation p is the observed pollution for the half-year, at a distance of 1500 yd and averaged over an octant about the power station, f(0) is the percentage frequency of occurrence of wind directions in the corresponding octant, u is the corresponding mean wind speed, and S is the average monthly output of sulfur dioxide during the half-year.

The quantity a, logically a "background" pollution, has values which are close to the winter and summer pollution existing immediately before the power station was commissioned. The magnitude of the coefficient b is shown to be consistent with previous ideas and other recent data on the vertical diffusion from an elevated point source. - Authors' Abst.

371. Measuring Air Quality. USDHEW, PHS, RATSEC, Cincinnati, Ohio, 1963, 20 pp.

Continual exposure to low concentrations of air pollutants may cause gradual deterioration of health, chronic disease, and premature death. Accurate measurements of pollution levels are essential to the work of various persons in the field of air pollution control. The oldest USPHS program of air quality measurement is the Natl. Air Sampling Network (NASN) established in 1953. The basic Network consists of 225 sampling stations of which some are active only in alternate yrs., making a total of 175 stations which are active in any given yr. These sampling stations are operated on a voluntary basis. Samples of suspended particulate pollutants are taken from the air once every 2 weeks at each operating station. This program yields about 4500 samples/yr. which is as many as the Network's currently available laboratory facilities can handle. The samples are collected using a high-vol. air sampler and glass-fiber filters. Gaseous pollutants are now being sampled at more than 50 stations. Continuous air monitoring is being carried out at 9 major urban communities through the use of automatic instruments. Samples at about 30 stations are being collected in receptacles especially designed to open only during periods of rainfall. On a national basis for a 4-yr. period the concentration (mg./m.^{3}) of suspended particulate matter, in urban areas, averaged 124, with a range of 1706 to 10. The benzene-soluble organics were 10.2, with a range of 123.9 to 0.1. For the nonurban areas, the suspended particulate matter averaged 37, with a range of 461 to 1. The benzene-soluble organics of the nonurban areas averaged 1.7, with a range of 13.7 to 0.1 Average concentrations of sulfur dioxide over a 24-hr. period showed SO_2 to be 0.03 ppm. with a range of 1.40 to 0.01; NO_2 averaged 0.05 ppm., with a range of 0.26 to 0.01. A chart in the text, which summarizes the continuous air monitoring data for 1 month, shows that the average pollution levels recorded at 5-min. intervals may be as much as 5 times higher than the average over 24 hrs. - APCA

372. Mecham, R.L., Ameen, J.S., and Slater, R.W.,Jr.: A Pilot Study of Air Quality in Winston-Salem, North Carolina, Nov. 28 - Dec. 5, 1962. Forsyth County Health Depart., North Carolina State Board of Health, USDHEW, PHS, Cincinnati, Ohio, April 1963, 25 pp.

Results of this study give a preliminary indication of general conditions of air quality in Winston-Salem. It must be emphasized that a one-week pilot study of this type covering a limited number of pollutants at a single location and during a short period in a particular season of the year, can only be used within its context.

Throughout the entire study, wind speeds were two to three times the normal values for the season. Such abnormal wind conditions had a considerable effect on the results of the study. Even under these favorable conditions for dispersion of pollutants, high soiling index values were observed. Oxidant concentrations indicated the possibility that photochemical smog may be a problem. Infrequent peak concentrations of sulfur dioxide point out a possible problem from that gas.

Upon consideration of the data collected in the 1-week sampling study and other available data, the following recommendations can be made: 1. Further emphasis must be placed on enforcement of the existing smoke control ordinance in the city. 2. The sources of particulate pollution responsible for the undesirably high total particulate loadings in the air over Winston-Salem should be determined and appropriate action should be taken to reduce these emissions. 3. Additional sampling should be conducted to determine whether a sulfur dioxide problem exists. 4. Further surveillance of oxidant concentrations should be undertaken to better estimate the extent of the possible photochemical smog problem. - Authors' Concl.

373. Meetham, A.R.: The behavior of sulfur dioxide in the atmosphere. In: Lodge, J.P., Jr. (editor): Atmospheric Chemistry of Chlorine and Sulfur Compounds. Geophysical Monograph No. 3, Am. Geophysical Union, Nat. Acad. Sc., Nat. Res. Council, Washington, D.C., 1959, pp. 115-121.

Many of the conclusions presented in this paper are of an empirical or speculative nature, but they can evidently be tested by experiment. The reaction rates of sulfur dioxide with films and drops of water in the presence of impurities could be for instance be measured by laboratory scale gas scrubbers. The time seems to be ripe, also, for a study of the physics and meteorology of radiation fogs, including water balance, heat balance, and the mechanism of mixing. Even more important is the systematic chemical analysis of the droplets of urban fogs, including their content of smoke particles. This should be preceded by the design of a fog water sampler which will not induce either the evaporation or the condensation of water during sampling. The whole life history of SO_2 from the instant when it enters the open air is of practical interest, because it is suspected to be the cause of a very great deal of damage. If we know how it reaches dangerous forms and concentrations, and how natural processes dispose of it, we shall be better able to reduce the harm it can do. - Author's Concl.

374. Meiter, E.G., and Traubert, C.E.: Sulfur dioxide in the air at the Pittsburgh Experiment Station of the U.S. Bureau of Mines. USBMRI 3005, June 1930.

A total of 304 determinations of the SO_2 content of the air at the Pittsburgh Experiment Station of the Bureau of Mines was made on 304 days during the period August 11, 1927, to August 11, 1928. The average amount found was 0.16 p.p.m. The maximum 1.1 p.p.m., was found on two days and less than the minimum detectable (less than 0.1 p.p.m.) on 141 days. On 134 days the concentration was between 0.1 and 0.4 p.p.m. inclusive and on 29 days the concentration was 0.5 to 1.1 p.p.m.

A general observation was made that the concentration tended to be higher on foggy or smoky days. Also, the concentration decreased with increase in wind velocity. The direction of the wind was not found to be a significant factor in changing the concentration. - Authors' Sum.

375. Moriguchi, M.: Atmospheric SO_2 in Tokyo District (Atmospheric Pollution, Pt.2). Papers in Meteorology & Geophysics (Tokyo) 6:144-149 (Sept.) 1955.

On examining the correlation of the variance of atmospheric SO_2 observed at each of the six stations in the Tokyo district from Jan. 18-24, 1955, the effects of wind direction and wind force on the concentration of SO_2 were found out, and the correlations of the concentration of SO_2 with atmospheric dust number, and with visibility were obtained. - PHEA

376. Morik, J.: Experiences in air hygiene research in Hungary up to the present time. Nepegeszsegugy (Budapest) 43:39-42 (Feb.) 1962.

In Budapest at the present time, the level of air pollution is 40-50% higher than in the 1930's. Industrial installations now ring the city, and the possibilities of severe smog incidents are increasing. The next greatest source of air pollution is from the railways and from the bus stations. During the period of April 1, 1958 through December 31, 1960 the average figures for air pollution in Greater Budapest were: for deposited dust, 171 tons/km.^{2}; for soot, 1.11 mgm./m.^{3}; for total sulfur, 21.49 mgm./100 hours; for sulfur dioxide, 0.68 mgm./m.^{3}; for chlorine and chloride, 0.47 mgm./m.^{3}; and for carbon dioxide, 0.042% by volume. The coal tar content of the deposited dust varied from 1 to 2%. During the winter heating period, the content of 3,4-benzpyrene ranged from 8×10^{-7} to 10.6×10^{-4} mgm. An interesting observation gained by tests on Gellert Hill and from airplanes, showed that pollution was not homogenous but that it was definite layers according to the distance from the ground. Periods of very high pollution levels were noted in January and February of each of the years 1958 through 1961. In addition such a period occurred during March 15-17, 1959. In that latter period, when visibility was so obscured that there was little daylight, visibility between 10:00 and 11:00 a.m. was limited to 80 meters in the heart of the city. At that time the soot content was 5.4 mg./m.^{3} and the SO_2 content exceeded 4 mgm./m.^{3}. These figures exceed the permissible limits by 10 to 15 times. There was considerable irritation to the eyes and nose and persons experienced the sour taste of SO_2-H_2SO_4. Currently in all of 12 industrial areas of Hungary the air pollution levels exceed the permissible limits at least seasonally and some of them most of the time. In all, 20 industrial cities are so affected. Following World War II, the great increase in industrialization brought about the building of new cities also. In these cities the industrial areas have generally been built separately from the residential areas. Remodeling of the older cities is gradually being done and in many of these belts of greenery are being used. - APCA

377. Morris, D.R.: Air pollution and the weather. Refrig. Eng. 38:83, 1939.

Air pollution results principally from the burning of coal from which noxious gases and solid particles escape into the air. "It is estimated that in a single Chicago plant 500 tons of sulfur as sulfuric acid escape into the atmosphere every 24 hours." Five percent of the coal goes into the air as unburned carbon. Wind velocity and direction determine the rate and region in which smoke is dispelled. - BAAP

378. Motley, H.L., and Phelps, H.W.: Pulmonary function impairment produced by atmospheric pollution. Dis. Chest 45:154-162 (Feb.) 1964.

1. The Los Angeles smog was found to aggravate the severity of emphysema by increasing the residual air and impairing still further air distribution in the lungs. 2. The Tokyo-Yokohama asthma type probably should be referred to as an allergic bronchitis, and this condition probably exists in many parts of the world. The control of the military personnel in Japan by the armed forces is unique, and this method of studying the effects of air pollution is not available in most other areas. Airway obstruction was a consistent finding, often associated with increased residual air and hypoxia. The present outlook is less favorable than at first thought regarding complete reversibility when the subjects stay too long in the Tokyo-Yokohama area after the condition has become manifest. 3. The use of treatment rooms with air filtered over activated carbon has been demonstrated to protect patients against air pollution in Los Angeles and in the Tokyo-Yokohama areas. 4. An allergic type of bronchitis was demonstrated in an industry from the introduction of two chemicals in the manufacturing process, and the clinical and physiologic findings in the sensitive patients were similar to the Tokyo-Yokohama asthma type. 5. Cigarette

smoking (personal air pollution) irritates the bronchial epithelium and appears to be an important factor in rendering individuals more susceptible to allergic factors in air pollution. Cigarette smoking impairs the transfer of oxygen to the blood from the lungs in severe emphysema. 6. Air pollution has become a serious medical problem in many of the larger cities of the United States, and all possible measures should be taken to reduce the pollution from all sources and to prevent further increases. - Authors' Sum.

379. Naughton, J.J., Heald, E.F., and Barnes, I.L., Jr.: The chemistry of volcanic gases. 1. Collection and analysis of equilibrium mixtures by gas chromatography. J. Geophys. Res. 68:539-544 (Jan. 15) 1963.

An adsorption method for the collection of volcanic gases is described. After collection of the samples, oxidation by contaminating air may convert hydrogen sulfide into sulfur dioxide, and reactions such as $2H_2S + SO_2 \quad 3S(s) + 2H_2O$ may result in removal of both these sulfur-containing gases by precipitation. Methods of collection most used in Hawaii have been the pump-through and the vacuum bulb methods. A method of analysis of volcanic gas samples has been developed in which adaptation of known gas chromatographic techniques are used. It is rapid, precise, and easily adapted to new situations. - APCA

380. Newall, H.E., and Eaves, A.: The effect of wind speed and rainfall on the concentration of sulfur dioxide in the atmosphere. Internat. J. Air & Water Poll. 6:173-177 (May-Aug.) 1962.

In a study made of the effect of wind speed and rainfall on sulfur dioxide pollution in the winter months of the years 1956-1960, it was found that the average daily concentration of sulfur dioxide was an inverse function of the corresponding wind speed, but that it was not apparently related to rainfall. - Authors' Abst.

381. Oderr, C.P.: Emphysema, soot, and pulmonary circulation. Macroscopic studies of aging lungs. J. A.M.A. 172:1991-1998 (April 30) 1960.

Two hundred lungs, obtained from persons dying of diseases other than pulmonary tuberculosis, wer fixed in the inflated state to permit study of the relation between emphysema and deposits of soot. The evidence showed that chronic emphysema usually develops 1st in small areas of trapped parenchymal soot deposits; it is manifested by abnormal fenestrations in the interalveolar septums and by increased diam. of the alveolar ducts. The emphysema accompanying deposits of soot can be explained as resulting from tissue defects and disarrayed mechanical forces. Precapillary vessels are found protruding into the air spaces at the alveolar duct level, providing a possible mechanism for correlation between aerodynamics and hydrodynamics in the lung parenchyma. The morphological basis for an extensive semishunt mechanism is demonstrated in the periphery of each lobe. - APCA

382. Ortuno, A.V.: Sulfurous contamination of the atmosphere. Ion (Madrid) 22:135-150 (March) 1962.

The author discusses some general aspects of air pollution, and notes that there have been various studies attempting to relate increasing pulmonary cancer incidence to the content of benzyprene in polluted air. Exhaust gases contain this substance in addition to oxides of carbon, oxides of nitrogen, aldehydes, and other materials. In recent investigations at Battelle Institute at Frankfurt/Main it has been demonstrated that the exhaust from a modern carburetor contains between 2 and 4% of CO under normal running conditions but that during periods of variation of speed in the running of the motor may increase to 16%. A Russian Inspector General of Sanitation had reported that in streets with heavy traffic (more than 3000 vehicles/hour) the level of CO had become 128 mg./m.^{3} and that drivers constantly exposed there had presented abnormal blood pictures and had suffered from vertigo, headaches, palpitations, and irritability. A professor of legal medicine in Barcelona has attributed some of the generalized illnesses and headaches of the railroad guards to air pollutants. Physical-chemical changes often occur following emissions of pollutants to the atmosphere. This happens with SO_2 which combines with moisture to form H_2SO_3 and H_2SO_4.

Mention is made of a long-time scandalous level of pollution from SO_2 and other gases at an industrial installation on the Riotinto River in the Province of Heulva. This condition was corrected by installation of various control equipment including the entrapping of SO_2 to produce H_2SO_4 as a saleable by-product. In Spain, in general, atmospheric pollution is not so great as to be considered a serious problem as yet although industrial installations and auto traffic are both increasing. Hence, in this short review (with its bibliography of 48 references, mostly English) dealing with sources, effects, and control of SO_2 in the atmosphere, the instances cited are most often those of other European countries, or of Canada and the U.S. - APCA

383. Paccagnella, B., and Fontanella, E.: A four-year study of atmospheric pollution in Padova by means of an average representative sampling method. Igiene moderna 52:363-414 (May-June) 1959.

After briefly considering the geographical, climatological, demographic and urban characteristics of Padova, results are reported from a 4-year systematic study of atmospheric pollution of the town, the study having been carried out with a method of average representative sampling. Standard deposit meters and lead peroxide cylinders were employed, following the suggestion of the English committee for the study of atmospheric pollution. The equipment was placed at eight locations over the urban area. Various charts and graphs in the text give information on local meteorological conditions, average amounts of deposited material and of sulfurous gases, and the distribution of pollution levels over the city. The average amount (g./100 m.^{2}/month) of insoluble material in the total of deposited material, over the 4-year period of 1955-58, varied from a low of 280 g. at station 1 to a high of 1023 g. at station 4. These similar figures for the summer-fall period (May-Sept.) were 408 g. for station 1 and 610 g. for station 4. During the winter period (Nov.-March) they were 198 g. and 1282 g., respectively. The average annual values for SO_3 during the 4-year period varied from a low of 0.54 mg./100 cm.^{2}/day at station 1 to a high of 2.17 mg. at station 4. - APCA

384. Pearson, J.L., Nonhebel, G., and Ulander, P.H.N.: The removal of smoke and acid constituents from flue gases by a non-effluent water process. J. Inst. Elect. Eng. 77:1-33 (July) 1935.

Progress in the electricity supply industry has led to a large increase in the coal consumption of individual power stations and is leading to the erection of power stations consuming over 1,000 tons of coal per day.

This concentration of coal consumption in a small area has greatly intensified certain aspects of atmospheric pollution, owing to the creation of "point" sources of very substantial emission, i.e. sources of an order of emission unknown some 25 to 30 years ago. The almost immediate effect of the developments in power station "size" has been to bring the 600-year-old question of atmospheric pollution to a stage insistent upon practical solution for the consumption of 1,000 tons of average coal leads to the formation and emission of 45 tons of sulfuric acid, 3 to 7 tons of nitric acid and half a ton of hydrochloric acid, as well as to substantial amounts of dust.

Three new power stations, Battersea, Swansea, and Fulham, indicate clearly the trend of flue-gas cleaning requirements in urban areas. In the past, manufacturers of flue-gas cleaning apparatus have devoted their activities, mainly to the removal of grit, partly to the removal of dust, and not at all to the removal of the acid constituents in the gas emission. This is well illustrated in Table 1, where under the second column of "Percentage removal" it will be seen that the performance of standard flue-gas cleaning apparatus in removing the acid constituents is negligible, except for the developments in new apparatus referred to at the end of the table.

It should be noted that the figures represent stated performances of plants and that the methods of testing were probably different in most cases and of unknown accuracy-except for the two cases at the end of the table. The table is mostly compiled from information given in the 1932 Report of the Committee appointed by the Electricity Commissioners and in a report of the Prime Movers Committee of the U.S.A. - Authors' Sum.

385. Perrott, G. St.J.: Sulfur dioxide as a factor in the smoke problem of Salt Lake City. USBMRI 2128, 1920.

Extensive experiments have shown that concentrations of sulfur dioxide below 0.5 parts per million have no injurious effect on growing crops or vegetation. "For injury to result with this concentration, continuous exposure throughout the growing period would be needed together with a high relative humidity of 80 to 100 percent. A concentration of 3 parts per million is necessary before the average individual can detect its presence." So in order for sulfur dioxide to be an important constituent in air pollution, its concentration must be 0.5 or 1.0 parts per million.

In this study 332 determinations were made. The highest concentration (0.8 parts per million) was noted on a foggy, smoky day with little wind. A table lists the results of the above 332 determinations. Samples from the upper level of the atmosphere were obtained by airplane. The results show that no heavy blanket of sulfur dioxide of high concentration was hanging over the city at any level below 3,000 feet. - BAAP

386. Perry, W.H., and Tabor, E.C.: National Air Sampling Network measurement of SO_2 and NO_2. Arch. Environ. Health 4:254-264 (March) 1962.

The air in the cities participating in the National Air Sampling Network is currently monitored for sulfur dioxide and nitrogen dioxide. The sulfur dioxide method used by the Network possesses good collection efficiency and sufficient sensitivity for the levels encountered. Slight losses of pollutant may occur in the inlet system and on aging of the solution after collection; these losses are minimized by periodic replacement of the prefilters and prompt analysis of all samples on receipt from the field. The nitrite solutions collected in the nitrogen dioxide method have adequate stability, and no significant influence is exerted by the inlet system. The method is necessarily empirical because of low collection efficiency and incomplete knowledge of the reactions involved in the conversion of mixtures of oxides of nitrogen to the nitrite ion. - APCA

387. Petrilli, F.L.: Methods of measuring sulfur dioxide, dustfall and suspended matter in city air, and their use in the study of air pollution in Italy. Bulletin of WHO 26 (No. 4):495-512, 1962.

This paper presents a comparative survey of the methods and apparatus used in Italy, particularly in Genoa, for measuring the 3 main components of city air pollution - sulfur dioxide, dustfall, and suspended matter.

The most frequently employed devices for sampling sulfur dioxide are the lead-peroxide and volumetric apparatuses, as developed by the British Department of Scientific and Industrial Research. For the collection of dustfall, the British standard deposit gauge is widely used; in Genoa, a simple, low-cost type of dustfall collector has been tried in combination with that gauge, and good results have been obtained. The measurement of suspended matter is effected by the thermal percipitator, electrostatic precipitator, and konimeters of different types, in addition to the classic method of filtration through various media. In Genoa, suspended matter is monitored by automatic filter-paper samplers and directional samplers. The use of membrane filters for counting dust particles has proved particularly satisfactory.

All these techniques are described in detail, and their results are subjected to statistical analysis. - PHEA

388. Plotnikova, M.M.: Basic investigations for the determination of the limit of allowable acrolein concentration in atmospheric air. In: Levine, B.S. (translator): Ryazanov, V.A. (editor): Limits of Allowable Concentrations of Atmospheric Pollutants. U.S. Depart. of Commerce, Office of Technical Services, Washington, D.C. Book 4, 1960, pp. 59-72.

0.8 mg/m^3 of acrolein was the threshold level of its odor perception by most sensitive persons. The threshold of acrolein reflex effect on optical chronaxy is at the level of 1.75 mg/m^3; on rhythm and amplitude of respiratory movement it was 1.5 mg/m^3. The threshold of acrolein reflex effect on eye sensitivity to light, as determined by the adaptometric method, was at the 0.6 mg/m^3 level, which is below the threshold level of its odor perception. Therefore, it is suggested that the maximum single limit of allowable concentration in atmospheric air, after making allowance for safety, be set at 0.3 mg/m^3. The investigation herein reported showed that the limit of allowable concentration of acrolein set at 2 mg/m^3 for air of working departments caused irritation of the conjunctiva and nasal mucosa, lowered eye sensitivity to light, as well as optical chronaxy and elicited changes in the rhythm and amplitude of the respiratory movements; therefore, it is suggested that the appropriateness of the official limit be restudied, with a view to its lowering. Results of the studies herein reported also showed that the atmospheric air surrounding the investigated oil drying plants contained acrolein concentrations in excess of the allowable limit even at 1,000 m from the plant. Therefore, it is suggested that the sanitary clearance zone between oil drying plants and residential sections be set at 1,000 m, even when the plants are equipped with gas purifying installations.

389. Popov, I.N., Cherkasov, Ye. F., and Trakhtman, O.L.: Determination of sulfur dioxide odor threshold concentration. Gigiena i Sanit. No. 5, pp. 16-20, 1952, in: Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U.S. Depart. of Commerce, Office of Technical Services, Washington, D.C., Vol. 3, May 1960, pp. 102-106.

The All-Union Sanitary Control Office appointed a special Committee of representatives from hygienic institutes to determine maximum allowable concentrations of pollutants present in the atmospheric air. The Committee prepared two concentration standards for sulfur dioxide: a maximum single dose of 0.75 mg/m^3 and an average daily concentration of 0.25 mg/m^3. The authors of this report undertook to find the threshold concentration of olfactory sensitivity to sulfur dioxide in atmospheric air, to determine its relation to the recommended standard maximum concentration of sulfur dioxide in the air, and to ascertain whether the odor receptor apparatus could be used in the control of concentrations of noxious odor-emanating gases in the air.

Soviet hygienists regard freedom from odor as a basic requisite. The present sanitary regulations prescribe 0.25 mg/m^3 as the maximum daily average SO_2 concentration and 0.75 mg/m^3 as the maximal single SO_2 concentration in atmospheric air. Results of this investigation show such concentrations to be above the threshold of SO_2 odor perception. It is suggested that they be replaced by results of more recent and more sensitive studies.

390. Primavesi, C.A., Hoffman, A., and Eikmanns, K.H.: Studies on the sulfur dioxide concentration in the air according to place and time in a big city in the Ruhr District. Arch. Hyg. (Berlin) 147:81-93, 1963.

The levels and fluctuations of SO_2 in the air were observed with autoregistering instruments at 7 points of an 100km^2 area including the following cities: Gelsenkirchen, Westerholt, and Marl. Excessive values were observed more frequently in populated areas. The average monthly SO_2 concentrations fluctuated in the course of the seasons. The SO_2 concentrations during the night were generally only 80% of the day concentration. A weekly rhythm was observed with maxima on Wednesday and Thursday, and minimum on Sunday.

391. Prindle, R.A.: Notes made during the London smog in December 1962. Arch. Environ. Health 7:493-496 (Oct.) 1963.

Author relates impressions and experiences of his visit to London during the smog episode of December 1962. On the evening of his arrival Dec. 6, he noticed "...a continuous metallic taste in the mouth and irritation of the nose, pharynx, and eyes...visibility outside the hotel was about 15 feet..."

Author visited several hospital wards and interviewed some of the patients with chronic bronchitis who were affected by this smog episode. All of the patients interviewed had had long-standing chronic bronchitis. Several indicated that they suffered prior episodes associated with the 1952 and 1957 smogs. One hundred and thirty three excess deaths were estimated in the city of London. Data gathered indicated that the smoke levels of the present episode were about one third of those in 1952, but that the SO_2 was about the same. It seems quite likely that the smog episode was nowhere as severe as 1952, and the changing situation in London, including the smokeless zones, new buildings and better utilization of fuel, have all contributed, along with certain meteorological events, for the betterment. Author mentions the stack gas sulfur dioxide removal project and a study of diesel emissions of the Warren Spring Laboratory at Stevenage.

392. Quon, J.E.: Combustion nuclei. Arch. Environ. Health 7:600-611 (Nov.) 1963.

Particulate and gaseous pollutants result from combustion processes involving the use of carbonaceous fuels. Combustion processes are prolific sources of "combustion nuclei," carbon-rich particles whose radii range from 1 to 100 mu. Unique physical and chemical properties of combustion nuclei are important in the manifestation of many air pollution effects.

Greater fog frequency and persistence have been attributed to increases in nuclei concentration. A continual source of nuclei can result in a large concentration of submicron particles which are effective in reducing visibility drastically.

Radioactivity in the atmosphere is largely associated with particles of nuclei dimensions. Since retention of both nuclei and submicron-size particles by the respiratory system is high, combustion nuclei represent a real hazard to the respiratory system. The production of submicron particles from nuclei through the process of coagulation is also of physiologic importance since submicron particles can exert, under certain circumstances, a synergistic intensification of the effects of irritant gases upon living cells. A topical concentration of 1,000-fold above the ambient irritant gas concentration is possible. An antagonistic effect is a possible explanation of the lower incidence of vegetation damage observed in the field as compared with the expected occurrences based upon laboratory observations.

Greater knowledge of the physical, chemical, and physiological behavior of combustion nuclei can elucidate the important, although vaguely understood, role of combustion nuclei to air pollution and its effects. An air quality index based upon the concentrations and properties of combustion nuclei is a distinct possibility. - Author's Sum.

393. Regan, C.J.: The air of London. J. Royal Inst. Pub. Health Hyg. 9:382, 1946.

A summary is presented of the work done in the past several years on the determination of the contents of the atmosphere over London. - BAAP

394. Regan, C.J.: A Chadwick lecture on air pollution. Smokeless Air J. Nat. Soc. Clean Air 88:67-76, 1953.

This paper deals with a lecture at the Royal Society of Arts, Oct. 15, 1953, describing the solid matter and injurious gases (chiefly SO_2) emitted into the air in Britain; their effects on health, on agriculture, the corrosive effect on metals and stone, and the damaging effect on fabrics. The effect of oxides of sulfur, gasoline and diesel fumes on pulmonary function are also discussed and remedial measures considered.

395. Richards, L.M.: Survey of the concentration of sulfur dioxide in the air of Southwest London: A first appraisal of results. J. Inst. Fuel 25:261-266 and 276, 1952.

This survey was designed to study the effects of the postwar restarting of flue-gas washing at Fulham and Battersea electricity generating stations on the pollution of the nearby air with SO_2. During the period of the survey (1945-1950) however, none of the gas from Fulham and only part of that from Battersea has been treated; at the same time there has been an increase in the fuel consumption at these stations, so the reduction in the SO_2 emission of the stations has been small in relation to the total emission of the stations in the area. Estms of SO_2 were made by the PbO_2 method at 30 sites, at distances up to 4 miles from the stations, and the pertinent pattern of summer and winter pollution thus disclosed have been shown on contour maps. - PHEA

396. Ronge, H.: Air pollution studies in Gothenburg. Nord. Hyg. T. 43:39-41, 1962. Excerpta Medica (Pub. Health Soc. Med. & Hyg.) 9:82 (Jan.) 1963.

This is a preliminary progress report of the first year's study of the air pollution problem in Gothenburg, Sweden. Data from 30 standard deposit gauges which were placed in different locations in the city and its suburbs, are discussed, also data on sulfur dioxide and smoke content of the air. The importance of a continued and enlarged program to curb pollution of the air is advocated.

397. Rosival, L., and Strecha, M.: Air pollution by sulfur dioxide, hydrogen sulfide and carbon disulfide. Smokeless Air, Spring 1960, pp. 194-199.

This article reports a study in Bratislava of the pollution of the atmosphere by sulfur dioxide, hydrogen sulfide and carbon disulfide. Sulfur dioxide was examined polarographically (after a method of Rouba) in the ambient atmosphere. The highest concentration appeared at the main railway station (.706 mg/m^3) and the residential center of town (.623 mg/m^3). Levels are much lower in suburban areas (.0254 mg/m^3). Seasonably, highest levels occur in the winter and lowers in the summer (winter average 7 a.m. to 3 p.m.) concentrations are 7-1/2 times similar summer values). Sulfur dioxide concentrations correlate with temperature (r=0.892), and relative dampness (r= +0.863), but not with atmospheric pressure (r=0.001). Sulfur dioxide was also measured in the atmosphere of 3 large chemical works. Hydrogen sulfide was measured in air samples taken from a large manufacturer of viscose thread, and at distances of up to 1500 m. from this source. Carbon disulfide was measured during sulfidation and in the spinning room of a viscose thread manufacturer. - PHEA

398. Santa Clara County Health Dept. (Turner, W.E. Director): Air Pollution Report 1948-1955. Santa Clara County Health Dept. 1955, 11 pp.

Santa Clara County is at the southern end of the San Francisco bay area, and its air pollution problem is intensified by the prevailing winds which sweep pollutants into a pocket comprising most of the county, where they remain in periods of inversion. This report describes the control program which has been in effect several years, including air sampling and analysis, reduction of pollution from existing sources and review of plans for new industry. The program is being carried out with the cooperation of industry. Air analysis reveals the presence of the common pollutants, including O_3 and other oxidants (0.05 ppm-usual concentration), aldehydes (0.05 ppm), N oxides (0.02 ppm), S oxides (0.02 ppm), CO (0.2 ppm) and PM (100 µg./$m.^3$). All these are ca. 20-25% of the usual concentration found in the Los Angeles area. Other factors in air pollution are H_2S arising from the dumping of garbage into the bay and insecticides from spraying. The problem will become acute as the area is more largely industrialized, and it is hoped that control measures at this stage will prevent a repetition of the situation now existing in Los Angeles. - KB

399. Schrenk, H.H., Heimann, H., Clayton, G.D., Gafafer, W.M., and Wexler, H.: Air Pollution in Donora, Pennsylvania. Epidemiology of the Unusual Smog Episode of Oct. 1948. Pub. Health Bull. No. 306, Federal Security Agency, Washington, D.C., 1949, 173 pp.

In the latter part of October 1948, Donora, Pennsylvania, a town of about 13,000 population, containing a zinc plant and a steel and wire plant, experienced a large number of acute illnesses and 20 deaths during a heavy smog. This report is based upon a carefully made epidemiological study, approached from the biological, the engineering, and meteorological point of view.

The data collection began after the episode was over and included: (1) Studies of acute morbidity by house-to-house canvass, records of fatal and hospitalized patients, and, finally, study of general morbidity; (2) Study of chronic morbidity by dental examinations of school children, by certain chest roentgenograms, and morbidity of selected groups of individuals; (3) Study of mortality records of the community and comparing them with similar records of neighboring towns; (4) Atmospheric studies of air pollutants; (5) Evaluation of industrial plant effluents; (6) Evaluation of air contaminants from other sources; (7) Description of the topography of the valley in which the town is located; (8) Micrometeorological studies of the valley; (9) Description of the weather during the acute episode in October, 1948.

Detailed descriptions of the methods used are presented since it was believed they would be useful to others making similar studies.

The study showed that the cause of the episode was an accumulation in the atmosphere of chemical irritants, this accumulation resulting from the weather inversion which existed in this part of the country during the fateful days. The parts played by all sources of chemical air contamination are discussed. A section is devoted to discussing the specific agent or agents probably responsible for the illnesses, and it is deduced that no one agent can be indicated. It was likely that it was due to a chemical irritant (possibly sulfur dioxide) plus particulate matter, although, because of the lack of knowledge about the toxic effects of low concentrations of the irritant gases, this cannot be said with certainty. - BAAP

400. Schueneman, J.J.: A Report on Activities and Observations Concerning Atmospheric Pollution in the City of St. Louis. Indust. Hyg. Section, Division of Health, City of St. Louis, July 1, 1949, 10 pp.

The history of atmospheric pollution control in St. Louis and the provisions under the smoke regulation ordinance (1940) and air pollution ordinance (1948) are reviewed. Various surveys by outside agencies for particular types of pollution were made. An investigation of SO_2 concentrations in the air over St. Louis and East St. Louis was made in 1936-37. During the winter (Oct. '36-April '37), the maximum concentration found was 2.266 ppm, the average concentration over the entire metropolitan area was 0.18 ppm and the average over the central district (5 mi. radius) was 0.256 ppm. In the summer (April '37-Oct. '37), the maximum concentration was 1.090 ppm, the average over the entire area - 0.060 and that over the central district - 0.119 ppm. In 1939-40 and in June 1946 dustfall studies and in July 1948 and Jan. 1949 surveys of suspended and settled matter were made. Pollen studies done in 1929-35 and 1937-39 revealed that the ragweed pollen counts were among the highest of those found in 32 large cities. CO concentrations found in downtown city streets in 1936 and '37 were high for relatively short periods at traffic rush hours, otherwise not serious. In Oct. 1946 a city-wide survey of settled dust gave results of 6.5-18.0% fly ash with an average of 10.6 and a median of 10.0% for the 18 stations. The records of the U.S. Weather Bureau for smoke, fog and smog show a 73% reduction of smoke in the 5 years following 1939-40. Also included in the discussion is a brief description of the types of pollution from different industries, of the methods of determination, standards, methods of control, procedure for securing abatement and the difficulties encountered. - KB

401. Schueneman, J.J.: Atmospheric concentrations of sulfur dioxide in St. Louis, 1950. Indust. Hyg. Quart. 12:30-36 (March) 1951.

The sulfur dioxide concentrations were determined during the winter and summer of 1950. It was found that these concentrations were 83% lower in the winter and 73% lower in the summer than they were in 1936-37. These reductions probably have been brought about partly by enforcement of provisions of the smoke regulation ordinance and partly by the increased use of oil and gas for fuel in place of coal. - Author's Sum.

402. Scott, J.A.: Fogs and deaths in London, December 1952. Pub. Health Rep. 68:474-479, 1953.

In this review of the London Fog of Dec. 1952, the daily concentration of smoke and SO_2 at London County Hall from Nov. 16-Dec. 27, 1952 are tabulated and graphed. Both show peak concentrations on Dec. 7 and 8 of 4.46 mg/m^3 smoke and 1.339 ppm SO_2, as compared with the summer (June) average concentrations of 0.12 mg/m^3 smoke and 0.07 ppm SO_2. The mean daily temperature was also recorded; a striking drop from the 80-year average is noted for the period, Dec. 5-8. The number of registered deaths in London increased sharply from 945 for the week ending Dec. 6 to 2,484 for the week ending Dec. 13; the number remained high (1,029-1,523) for the following 4 weeks ending Jan. 10, 1953. The increase in death rates was greater than that for the fog of 1873 or for the cholera epidemic of 1866. The deaths in the 6 weeks ending Dec. 27, 1952 are classified by age and the latter 3 weeks are compared with the average of the 1st 3 weeks. A 3-fold increase in deaths is shown for the 4th week (Dec. 7-13) for babies 4-52 weeks and for adults $>$55 and approximately a 2-fold increase for all other ages. The deaths are also classified by cause for each week in a similar manner as for age. Causes of death were almost entirely disorders of the circulatory and respiratory systems. Deaths from bronchitis for the week ending Dec. 13 were 10 times as many as those for the previous 3 weeks; from pulmonary t.b., 4½ times as many; from other respiratory diseases, 6 times as many; from lung cancer, 2 times as many and from disorders of the heart and circulatory system, 3 times as many. In the fog of 1873, greater mortality from respiratory and circulatory disorders and among the very young and old also occurred. Similarly, animals in the Smithfield cattle show became ill and some died during both fogs. - KB

403. Scott, J.A.: Fog and atmospheric pollution in London, winter 1958-59. M. Officer (London) 102:191-193 (Oct. 16) 1959.

The winter of 1958-59 was noteworthy for having a report of fog, as made by Kew Observatory, on 75 of the 182 days in the period of Oct. 1958 to March 1959, with 18 of these days being in the month of Nov. On 3 occasions, of 2 to 3 days each, during this period atmospheric pollution, as a combination of "smoke" and "sulfur dioxide," neared what has been found in practice in London to be a critical level in relation to mortality. Table I in the text shows the trend of atmospheric pollution in London, especially over the 5 winters from 1954-55 through 1958-59. These figures indicate that the amount of "sulfur dioxide" has remained relatively constant but there has been a downward trend in the amount of "smoke." In 1954-55 these figures were 49 mg. "smoke" (suspended black material)/100 m^3 of air to 11.1 parts of "sulfur dioxide" (acidic gases)/100 million parts of air, with a ratio of smoke to SO_2 of 4:41. In 1958-59 these figures were 43 and 11.9, with a ratio of 3:61. This reduction in smoke is probably a mirroring of the reduction in the consumption of coal. Although it would undoubtedly be well to have the SO_2 reduced also, previous work would indicate that in relation to mortality smoke appears to be more injurious to health. The persistent fog in Nov. 1958, unaccompanied by high pollution, had little effect on mortality. Also the near-smogs of Jan. and Feb. 1959 appeared to have little or no effect on mortality. These facts support the hypothesis that the level of pollution in London begins to exert a critical effect upon mortality when the daily concentration reaches 200 mg. black suspended matter/100 m^3 of air if it is combined with 40 parts of acidic gases/100 million parts of air, even though evidence so far does not preclude smoke being the determining factor rather than the combination of the 2 pollutants. - APCA

404. Scott, J.A.: The London fog of December 1962. M. Officer 109:250-252 (April 26) 1963.

In previous papers (Scott, 1956, 1958, 1959) it has been shown that, so far as London is concerned, a critical level of atmospheric pollution in relation to its effect on health was reached when the average daily concentrations of smoke and sulfur dioxide in the atmosphere were in the region of 200 milligrammes of black suspended matter per 100 cubic meters of air and 40 parts of sulfur dioxide per 100 million parts of air, i.e. about four times the average level of the winters 1954-55 and 1955-56. In terms of the now more commonly used unit of microgrammes per cubic meter this critical level is 2,000 for smoke and 1,140 for sulfur dioxide. - Author's Abst.

405. Seczyk, K.: Results of research on air pollution by sulfur dioxide in region of zinc industries in Silesia. Med. Doswiad. Spat. 15:296, 1932.

Gases emanating from zinc and lead foundries in the district of Katowice have been detrimental to the small nearby farms. These foundry gases are composed of particles of ore, coal dust, lead, zinc, sulfur dioxide, carbon dioxide, carbon monoxide, and possibly hydrogen sulfide and arsine. Because there is a limited demand for sulfuric acid, sulfur dioxide is discharged into the air.

Toxic effects of sulfur dioxide on man are described. Low concentrations cause "coughing and symptoms of scratchy mucous membranes of the respiratory passages. High concentrations damage mucous membranes and cause catarrh of bronchi, possibly hemorrhage, and finally inflammation of the lungs." There is apparently no effect on the blood. A permanent worker is not affected in a sulfur dioxide atmosphere, whereas a new man may feel ill.

Study was undertaken "to determine how sulfur dioxide is diluted in the atmosphere and at what radius from the center of production it settles and can act injuriously on people." The manner of carrying out research is described. It was found that a wind of uniform velocity (2 meters/sec.) does not appreciably dilute the sulfur dioxide.

Data are given for many sampling points: distance from the source of sulfur dioxide, concentration of sulfur dioxide, temperature, humidity, wind direction, and concentration of sulfur dioxide found at that point. Rain never favored the disposal of the gases because the concentration was higher in rain than during good weather.

The levels of sulfur dioxide obtained for Silesia were more damaging than those for Pittsburgh.

In fine weather, the sulfur dioxide content for the locality immediately about these foundries was lower than when there was a heavy fog, a low overcast, or rain. The wind played an important role in the distribution of the gases. Weak winds and calms appeared to disperse the gases much better than strong winds. Sulfur trioxide, hydrogen sulfide, and hydrogen fluoride were found in the chimney gases, but not in toxic amounts. - BAAP

406. Singh, A.D.: A Survey of Sulfur Dioxide Pollution in Chicago and Vicinity. A Report of an Investigation Conducted by the Engineering Experiment Station, University of Illinois, in Cooperation with the Smoke Inspection and Abatement Department, City of Chicago, Univ. Ill. Bull. 36, No. 37, Jan. 3, 1939, 32 pp.

The Smoke Inspection and Abatement Department of Chicago has kept records of smoke densities and dust falls, from which the Department has been able to determine the success of various methods of abatement. Until recently, however, no such studies have been made of the presence of noxious gases resulting from the combustion of sulfur in coal. To obtain information on noxious gas pollution, in January 1937, the Chemical Engineering Division of the Engineering Experiment Station at the University of Illinois, in cooperation with the Smoke Inspection and Abatement Department of Chicago, undertook a preliminary survey of the sulfur dioxide concentration in the air over that city.

The chief aims of the survey were to locate the principal sources of SO_2; to determine, if possible, how much each of these sources contributed to the general atmospheric pollution; to find the concentration of the general SO_2 pollution prevailing over the city. - Author's Introduct.

407. Stalker, W.W., Dickerson, R.C., and Kramer, G.D.: Sampling station and time requirements for urban air pollution surveys; part IV: 2-and 24-hour sulfur dioxide and summary of other pollutants. J. APCA 12:361-375 (Aug.) 1962.

Approximately 12,000 24-hour and 30,000 two-hour samples were collected and analyzed for sulfur dioxide during a one-year study of air pollution in Nashville, Tennessee.

The resulting data were evaluated in terms of the number of sampling stations and the sampling frequency required. - Authors' Sum. (modified)

408. Stalker, W.W., Kenline, P.A., Konopinski, V.J., and Paulus, H.J.: Nashville sulfur dioxide emission inventory and the relationship of emission to measured sulfur dioxide. Internat. J. Air & Water Poll. in press; Nashville Compendium Report, in press.

A detailed inventory of sulfur dioxide emissions was prepared as part of the Nashville Community Air Pollution Study conducted by the Public Health Service during 1958-59. The primary purpose of the inventory was to provide data for a study of the relationship between the emission of sulfur dioxide and measured ambient levels.

The development of the inventory, data collection methods, and calculations are described. Nine tables and seven figures are included.

Ambient levels of sulfur dioxide were related to average emissions of sulfur dioxide in such a way (correlation coefficient = 0.81) that mean seasonal concentrations of atmospheric sulfur dioxide in square-mile areas could be predicted with fairly good confidence from a knowledge of sulfur dioxide emissions. For these long-period (average) predictions meteorological variables can be disregarded.

On a square-mile basis, on the average, one ton of sulfur dioxide emitted per day produced a mean atmospheric sulfur dioxide concentration of 0.022 ppm, and 10 tons of sulfur dioxide per day produced a concentration of 0.067 ppm.

Emission inventory data would be useful for air pollution control purposes as well as to supply basic information for studying the above relationships.

409. Steigerwald, B.J.: Effects of air contaminants on atmospheric ions. Case Inst. Technol., 1962, 144 pp.

High concentrations of intermediate and large ions and very low concentrations of small ions are contained in urban air as compared with the air in rural areas. In order to study quantitatively the relationship between air contaminants and atmospheric ions large ion concentrations were used. For statistical analysis of data correlation and regression methods were used. Temperature, humidity, SO_2 and CO_2 at ambient concentrations had no effect on large ions. Large ion concentrations correlated only slightly with particulate stain concentration but correlated very strongly with automobile exhaust.

410. Stratmann, H.: Investigations of the sulfur dioxide content of air near the ground in the neighborhood of power stations burning bituminous coal. Mitt. V.G.B. 705-714 (Aug.) 1955.

The difficulties of theoretical estimates and practical determinations of SO_2 concentrations are discussed, and the method developed for measuring the concentrations near 2 power stations is outlined. (The detailed description of the specially-developed microanalytical method is published elsewhere.) The results are given in tables and graphs and are compared with values calculated from Sutton's and Bosanquet's equations. The maximum concentrations were found at distances between 1000 and 2000 m. from the stations and were independent of the chimney emission and chimney height; the average was 0.2 mg. SO_2/m.^{3} air and reached, in the winter months (fog), values of 0.5-1 mg./m.^{3} but never exceeded 1 mg./m.^{3}. The agreement between actual and calculated values is fair, but the calculated values are too high at low wind velocities and in highly populated regions. - APCA

411. Stratmann, H.: Investigation of sulfur content in pit-and lignite coal charges. Mitt. V.G.B. 23-30 (Feb.) 1958.

Investigations of sulfur balance in coal and lignite furnaces; sampling and analytical methods, and results obtained; flue gas analyses with different boiler furnaces; data on percentage of sulfur in flue gases. - PHEA

412. Sullivan, J.L.: Particulate and gaseous pollution in New South Wales cities. Proc. Clean Air Conference, Sydney, Feb. 19-21, 1962.

This paper discusses 3 industrial cities with smoke concentrations similar to America and British cities,with a sulfur dioxide concentration similar to American cities, and perceptible oxidant concentrations. Low level inversions are characteristic of this area and contain concentrate pollution from domestic and other low level sources. The industrial pollution, mainly SO_2, is discharged sufficiently high and hot to penetrate the inversion.

413. Sullivan, J.L.: The nature and extent of pollution by metallurgical industries in Port Kembla. (Part I.) In: Air Pollution by Metallurgical Industries, by Bell, A., and Sullivan, J.L. Division of Occupational Health, New South Wales Department of Public Health, Sidney, Australia, 1962, pp. 1:11-1:60.

This report deals with a survey of air pollution in a metallurgical town, Port Kembla, located on the east coast of Australia. Iron and copper ores are smelted and the major emissions consist of solid particles and sulfur dioxide gas. The presence of the latter is most noticeable in the wake of the plume of the stack of the copper smelter during the northeast winds which prevail in summer. In winter the prevailing winds cause industrial pollution to be blown seawards. Tests for sulfur dioxide were made by daily volumetric sampling instruments and a Thomas automatic recorder. The section of the town most severely affected consisted of a swathe of about 200 yards wide and extending to a point where habitation ceased about 0.6 miles from the 200-feet-high stack of the copper smelter. Daily readings of the gas content were not spectacular, the highest being 0.62 ppm. During a little more than three years 24-hour readings of 0.2 ppm or more were measured on 39 days. However, a different picture was obtained from the continuous recorder. This showed that high concentrations of sulfur dioxide tended to occur in episodes of a few hours each. Peaks of greater concentration than 5 ppm were recorded on numerous occasions and the maximum for the sampling period was 13.5 ppm at a point 0.45 miles from the source. Complaints of respiratory distress were made frequently and most householders had ceased to try to grow vegetables. Dust-fall rates measured as water-insoluble solids by a deposit gauge, consisting of a six-inch conical glass funnel and bottle, were high by normal standards. Average annual rates varied between 17.9 and 86.1 tons/mi.^{2}/month. In some locations within a half mile from the edge of the steel industries, the summer dust-fall rates were found to exceed 100 tons/mi.^{2}/month. At one point a mile and a half from the steel industries the monthly rate during 1960 varied between 13.6 and 43.4 tons/mi.^{2}. - APCA

414. Tabor, E.C., and Meeker, J.E.: Effects of the 1956 steel strike on air pollution levels in several communities. Proc. 51st Annual Meeting, APCA, Philadelphia, Pa., May 25-29, 1958.

The effects of the 1956 steel strike on the levels of atmospheric pollutants in four communities have been discussed in this paper. Here, for the first time, have been presented actual quantitative data regarding the differences in amounts and composition of suspended particulate pollutants resulting from the shutdown of steel mills in the major steel producing areas. The fact that lower levels were found during the strike period was not in itself surprising. On the other hand the occurrence of occasional high levels during the strike period indicates that there are sources contributing to pollution of the air which may not be obvious in the presence of an industry which is frequently looked upon as the major offender. - Authors' Abst.

415. Van Leeuwen, W.S.: Sulfur dioxide or hydrofluoric acid poisoning? The fog catastrophe in the industrial region of Luttich. Chem. Zentr. 1:807, 1933.

The cases of poisoning in the Meuse Valley in December 1930 were due to the formation of a fog loaded with the waste gases of numerous factories, chiefly sulfur dioxide and hydrofluoric acid. According to Fenner the poisoning effect was caused by the fluorine silicate or fluorsilicic acid in the factory gases. - BAAP

416. Wainwright, C.W.K., and Wilson, M.J.G.: Atmospheric pollution in a London Park. Internat. J. Air & Water Poll. 6:337-347 (Sept.-Oct.) 1962.

The concentration of atmospheric sulfur dioxide was recorded at a point in Hyde Park, London, and traverses of the park were made with portable apparatus. The rate of decrease of concentration with distance from the upwind edge was found to be closely related to the lapse rate but not to the wind speed. The rates of decrease with distance were greater than those calculated from the work of Lucas, and even large adjustments to the treatment would not make it fit all the experimental results. The discrepancy may be partly due to a current of cleaner air which descends into the park by natural convection. - APCA

417. Waller, R.E., and Lawther, P.J.: Some observations on London fog. British M. J. 2:1356-1358, 1955.

Though there were no long periods of dense fog in London during the winter 1954-55, visibility was reduced to $<$200 yds. for a few hr. at a time on several occasions, with accompanying increases in the levels of smoke and SO_2. Such a fog occurred the night of Dec. 15/16 when H_2SO_4 was also detected in the H_2O droplets in a concentration of ca. 1 mg./m.^{3}. On Jan. 19, 1955, very wide variations in the concentration of smoke were observed, and a 10-fold increase occurred in a 2-hr. period. There was also an increase in SO_2, but no H_2SO_4 was detected by the methods used, although traces might have been present in the form of minute droplets. The maximum concentrations measured were 6.5 mg. smoke/m.^{3} and 1 ppm SO_2. Most of the smoke particles were $<1\ \mu$ in diameter. The records of 29 patients with an established diagnosis of chronic bronchitis and emphysema, who had been daily recording their own assessment of their state of health since Oct. 1954, showed that a temporary deterioration in their clinical condition coincided with the fog episode. It is concluded that the results emphasize that measurements of pollution over 24- or 48-hr. periods do not necessarily indicate the hazard to which the population may be exposed. - KB

418. Waller, R.E., and Lawther, P.J.: Further observations on London fog. British M. J. pp. 1473-1475 (Dec. 21) 1957.

A close association has been found between the clinical condition of a group of 180 patients with chronic bronchitis and emphysema living in the Greater London area and the concentration of atmospheric pollution measured in the city. Although visibility was generally low at times when the patients were affected, the reduction was mainly due to smoke rather than water droplets. Dense wet fog was observed only rarely in Central London, and it did not appear to enhance the effects of high pollution. The concentration of smoke has been used as an index of pollution, but the actual pollutant responsible for the harmful effects on patients has not been identified. Sulfuric acid has been detected at times of high pollution, and its possible role is discussed. - Authors' Sum.

419. Waller, R.E.: Acid droplets in town air. Internat. J. Air & Water Poll. 7:773-778 (Oct.) 1963.

Slides impregnated with indicators have been used in a cascade impactor to detect the presence of acid droplets in urban air. Some acid has been found at all times in London and the acid droplets are most numerous during fog. Much of the acid is contained in droplets of less than 1 µ diameter, but larger ones do occur and acid "rain" has been observed in some atmospheric conditions. - Author's Abst.

420. Waller, R.E., Brooks, A.G.F., and Cartwright, J.: An electron microscope study of particles in town air. Internat. J. Air & Water Poll. 7:779-786 (Oct.) 1963.

The electron microscope has been used in a further study of the nature of suspended particulate matter collected from the air of London and Sheffield. In addition to the particles of carbon, tar and ash which had been reported earlier, droplets containing dissolved salts and sulfuric acid have now been recognized as common constituents of urban air. - Authors' Abst.

421. Wedin, B.: The tracking of pollutants in the atmosphere. Smokeless Air, pp. 193-220, Spring 1961.

In this article the author describes the work being done in Sweden on the dispersal of pollutants in plumes by the release in stack gases of fluorescent pigments, their collection on impactors mounted on aircraft, etc., and counting under the ultraviolet illumination. Examples of such surveys are illustrated. - Author's Abst.

422. Wilkins, E.T.: Air Pollution in a London Smog. Mech. Eng. 76:426-428, 1954.

Between December 5 and December 9, 1952, fog became polluted by solid, liquid, and gaseous emissions (largely from fuel combustion). Smoke, as determined by the filter-paper method, was 5-10 times (up to 4.5 mg./cu.m.) that for a normal December, and the SO_2 content (aspiration through H_2O_2 solution and titration of acidity, calculated entirely as SO_2) increased to a like extent, reaching 4.5 mg. per cu.m. In the outer area the maximum recorded concentrations of smoke were between 2 and 5 times the normal value and SO_2 between 2 and 7 times normal. The Pb peroxide method was also employed to study the relative SO_2 concentrations. The maximum values of SO_2 were below those permissible for continuous exposure. - PHEA

423. Wilkins, E.T.: Air pollution and the London fog of December, 1952. J. Royal Sanit. Inst. 74:1-15, 1954.

This is a discussion of the air pollutants present during the Dec., 1952 London smog and their significance by the officer-in-charge, Atmospheric Pollution Section of the Fuel Research Station of the Department of Scientific and Industrial Research, London which cooperated in the investigation by collecting all available data on the concentrations of pollutants in different parts of the affected area.

The sources of air pollutants in town air, the meteorological conditions for fog formation and the methods used in the pollution measurements are reviewed.

The daily smoke and SO_2 concentrations for Dec. 2-10, 1952 are tabulated showing maximum concentrations of 3-10 times the normal values for smoke and 3-12 times the normal for SO_2 to have occurred from Dec. 5-9 at individual sites as compared with the mean values for Dec., 1951. A comparison is made of smoke and SO_2 concentrations in London for Dec. 5-9, 1952 and Nov. 26 - Dec. 1, 1948 when severe smog also occurred. In general, the maximum and mean concentrations of both smoke and SO_2 in 1948 were about 50 and 70% of the 1952 values. A comparison of pollution in 1952 at the London sites, at sites in 7 towns which reported fog on 2 or more days during the smog period and at 8 towns which reported no smog showed appreciable increase of both smoke and SO_2 above normal even where no fog was reported. Probably, therefore, inversion conditions causing pollution increases were general even though there was no persistent fog in some of the affected areas. The greatest concentration of pollution occurred over the Westminster area with a zone of lesser concentration spreading along the riverside areas. The presence of other possible pollutants, i.e., CO, CO_2, H_2SO_4 mist and tar, which were not measured, is discussed. The mortality of the period is discussed with a graphed illustration of the striking parallelism between the death rate and the concentrations of SO_2 and smoke. A secondary, but more extended peak in the mortality curve is noted for Jan. and Feb. Although others had attributed this to factors other than smog, including an outbreak of influenza, the author notes that during this period there was again a generally rising level of pollution to twice the normal value. He concludes that this was a second pollution shock to Londoners with resistance lowered by the earlier smog.

Since this smog was the most disastrous in the past 80 yrs., the question is raised whether it was due to freak meteorological conditions, or to change in character or amount of any one pollutant or to both. Two factors are mentioned in this connection. One is the increasing concentration of SO_3 from both direct emissions and the oxidation of SO_2 in the atmosphere by the presence of oxides of N and certain types of particles acting as catalysts and O_3 with the subsequent formation of H_2SO_4 mist; all these reactions are favored during fog conditions. The 2nd is the exceptionally sticky or tarry nature of the grime which Londoners reported settled from the smog attributed to the increased use of a type of domestic open-fire designed to stay alight all night, and thus emitting smoke and distillation products at night. - Author's Sum.

424. Wyszynska, H., and Kosinski, K.: Sulfur dioxide determination by means of contact method in the air of Warsaw. Roczniki Zakladu Hyg. (Warsaw) 13:377-383, 1962.

The method for SO_2 determinations in atmospheric air, based upon the absorption of the gas in cloth saturated with lead dioxide is presented. The method is simple with no special apparatus being necessary, thus making it applicable for use in sanitary-epidemiological stations. On the basis of the results from the examinations over a period of a yr. (1961-62) from 9 collection points in Warsaw, it was stated that the SO_2 content varied from 0.08 to 2.60 mg./100 cm.^{2} PbO_2/day, which corresponds to 0.01 to 0.23 mg.SO_2/m.^{3} of air. During the periods of house-heating, the values were 5-fold higher than during the summer season. - APCA

425. Youden, W.J.: Fluctuations of atmospheric sulfur dioxide: Contrib. Boyce Thompson Inst. 11:473-484, 1941.

Examination of a continuous record of SO_2 concentration in the atmosphere at Boyce Thompson Institute shows a daily cycle which changes form during the seasons. In the winter months the concentration builds up during the day to ca. 60 ppm and falls off to ca. 35 ppm in the night. In other seasons a drop to ca. 10 ppm occurs in the early afternoon and is probably the result of northerly breezes at that time of day. These concentrations are for the average cycle. There is a weekly cycle, found at all seasons, in which the concentration is low on Sunday and Monday and increases by about 50% to a maximum on Thursday and Friday. The annual cycle follows a sine-shaped curve with a minimum of 15 ppm SO_2 in the summer to a maximum of 50 ppm in the winter. The influence of the weather was brought out by driving regression equations which show a strong correlation of SO_2 concentration with wind direction and velocity, temperature and, to some extent, with rainfall. - KB

426. Zanetti, M., Bisbini, P., and Cutrufelli, F.: Air pollution of the City of Bologna. Behavior of SO_2, NH_3, and NO. Nuovi ann. igiene e microbiol. (Rome) 11:191-200 (May-June) 1960.

The degree of air pollution, indicated by measuring the content of sulfur dioxide, ammonia gas, and nitric oxide in the atmosphere of the city of Bologna was studied during the period of November 1, 1959, through March 31, 1960. One of the two sampling stations was situated near the Inst. Hygiene of the University in a small town and the other near the office of Municipal Hygiene. The latter building is situated in the center of the city near numerous other buildings, public offices, and dwellings and in a zone of intense motor traffic. The content of SO_2 was found to increase from November 1959, through February 1960, with the peaks being reached often in January, and then to decrease somewhat in March. The average concentrations, from the Univ. station, ranged from 0.07 to 0.16 ppm., dropping to 0.05 in March; from the other station, these figures were 0.10 to 0.17. A graph for the period of December 1959, through January 1960, and based on the results of two different types of collectors, indicated ranges of 0.02 to 0.25 and 0.10 to 0.33. A 24-hr. graph of SO_2 concentration indicated the highest concentrations (0.27 ppm) to be between 10:00 a.m. and noon and the lowest (0.02 ppm) to be between 3:00 and 4:00 a.m. NH_3 measured as ppm of N, from November 1959 through March 1960, increased regularly at the first station from an average of 0.004 through 0.201; at the second station, from 0.006 through 0.13. NO, over a similar period, increased from 0.006 through 0.010 until January, when the concentration began to drop, reaching .008 in March. At the municipal station these figures for NO were 0.006 to 0.010 with a decrease to 0.009. - APCA

427. Zurlo, M.: Measurement of the sulfur trioxide content of the air. Med. lavoro (Milan) 53:325-329 (May) 1962.

An accurate, sensitive, very simple titration method for the determination of atmospheric SO_3 is described. The ion SO_4, in the presence of acetone, decolorizes a lake of thorium-eriochrome cyanine R. A very sensitive colorimetric method is based on this reaction; it is, however, easily influenced by small variations in pH and by the interference of other substances (HF, H_3PO_4). The titration method eliminates these disadvantages. The titration is carried out using a dilute thorium nitrate solution. Under set conditions (pH of 3.5 in presence of acetone) the SO_4 ions react quantitatively with thorium; lake is formed and the end point is thus obtained when all SO_4 ions, and any other interfering substances, have combined with thorium. Together with the sample titration, a blank is performed in the presence of barium chloride which, by combining with the SO_4 ion, prevents its reaction with thorium. In this way only interfering substances (HF, H_3PO_4) are titrated. The difference between the two titrations is specific for H_2SO_4. The titration error is inferior to 0.5 μg SO_3. Interfering metals may be eliminated by the addition of ethylenediamintetracetic acid (EDTA) slightly in excess of the stoichiometric volume. The interfering action of iron may be eliminated by the addition of KCN. - APCA

428. Zurlo, N. and Griffini, A.M.: Measurement of the sulfur dioxide content of the air in the presence of oxides of nitrogen and heavy metals. Med. lavoro (Milan) 53:330-335 (May) 1962.

This study was conducted to eliminate the interference of oxides of nitrogen and heavy metals in the colorimetric method of West and Gaeke for the determination of sulfur dioxide. It has been proved by preliminary tests that the interference of NO_2 was not due to the reaction of NO_2 with SO_2, as was generally believed, but was due to the reaction of NO_2 with fuchsin or with fuchsin which had reacted with SO_2. To eliminate the interference it is enough to destroy the NO_2. Keeping this in mind, urea, sulfanilic acid, and o-toluidine were tried, with o-toluidine showing good results. For the total destruction of the nitrites (10 µg) it was necessary to use at least 0.2 ml. of a 1% o-toluidine solution for every 10 ml. of the sample. This reduces the chromatic intensity only by 20%. Tetrachloromercurate protects the SO_2 from oxidation; the protection, however, is incomplete in the presence of heavy metals, especially of iron salts. With Mn and Cr, SO_2 was oxidized in stoichiometric quantities corresponding to the reduction of metals of inferior valence; with ferrous and ferric iron, SO_2 was completely oxidized, even when present in a notably higher concentration than the stoichiometric equivalent. Iron oxidizes SO_2, itself being reduced to the ferrous salt, which is reoxidized by oxygen contained in the air, thus acting as an oxygen carrier. To estimate SO_2 in the presence of iron salts, one has to block the iron by adding a chelate to the solution, more precisely ethylenediamintetracetic acid (EDTA), in amounts of 70 µg of EDTA to every 10 µg of Fe. The EDTA does not interfere with the chromatic reaction of fuchsin-SO_2, and protects SO_2 completely. - APCA

429. Amdur, M.O.: Hazards to health. Air pollution and human health - chronic biologic effects. New England J. Med. 266:555-556 (March 15) 1962.

Several studies on "chronic bronchitis," a disease condition which is more prevalent in Great Britain than elsewhere, point to air pollution as a contributing factor in the etiology of that disease. Some of the evidence resulting from studies of chronic changes in animals exposed to various irritant air pollutants over periods of weeks or months, is reviewed. Evidence of respiratory system damage has been presented following animal experimentation with ozone and SO_2, as well as information on changes in fertility rate and survival time of new born mice. It is possible that the various irritants present in urban atmospheres may also enhance the potency of even very small amounts of carcinogenic substances. Some irritants decrease the rate of ciliary activity in the respiratory tract, thus interfering with 1 of the mechanisms that normally remove inhaled particulate matter from the airways. This could lead to prolonged contact of carcinogens with sensitive tissue. Damage from chronic irritation to the epithelial lining of the airways could render it more susceptible to the action of carcinogens. These possibilities represent another aspect of the potential interaction of air pollutants that need investigation. - APCA

430. Andelman, S.L.: Air pollution, the respiratory tract, and public health. Eye, Ear, Nose, Throat Monthly 39:961-964 (Dec.) 1960.

Effects of aerial sewage on human health range from irritation of the nose, throat, and eyes to aggravation of respiratory tract disorders and cardiovascular ailments. Evidence has been accumulating to link polluted air to the increased incidence of chronic bronchitis, emphysema, bronchospasm, and lung cancer among urban dwellers. Sulfur dioxide has been identified as the principal culprit of the air pollutant family, with ozone being the 2nd most important gaseous offender. The latter gas is a product of the photochemical oxidation of hydrocarbons derived from the partial combustion of gasoline and diesel fuel. Atmospheric concentrations above 0.2 ppm. irritate the air passages of the respiratory tract, cause pain in the chest, cough, dyspnea, and nausea. Exhaust system smog purifiers, as in the approved devices in California, are expected to decrease substantially the amount of carbon monoxide present in the exhaust stream by 60% and the amount of hydrocarbons by as much as 80%. Air pollution was officially recognized as the greatest and most urgent environmental problem facing the peoples of Europe during the World Health Organization Meeting held in Geneva in 1958. The City of Chicago has recently enacted 1 of the foremost comprehensive air pollution ordinances, and the Mayor has appointed 3 Committees, namely; A Control Committee, a Technical Advisory Board, and a Control Appeal Board, to assist the Dept. of Air Poll. in carrying out the provisions of the law. Extensive statistical data are now being gathered. - APCA

431. Anderson, R.J.: Epidemiologic studies of air pollution. Dis. Chest 42:474-481 (Nov.) 1962.

Supplementing existing data which indicate an association between disease and air pollution, new epidemiologic studies provide evidence on the relationship of malignant neoplasms of the lung to air pollution, the distribution of deaths resulting from emphysema and the apparent increase in this disease, the relationship of asthmatic attack rates to air pollution as measured by sulfur dioxide, and the effects of air pollution exposure on pulmonary function in a normal population.

Since epidemiologic studies cannot provide "cause-and-effect" proof, the author postulates that they must be supplemented by laboratory and other studies to strengthen the evidence. In order to establish "proof" that air pollution adversely affects human health, one must have: (1) statistical evidence that a certain disease condition exists in the population; (2) epidemiologic evidence of the association between this disease condition and a certain factor or factors present; (3) laboratory demonstration that such factors can produce a condition in experimental subjects similar to that found in the population; and (4) the ultimate demonstration that protection from such factors will lessen the amount or severity of the disease condition. - Authors' Sum.

432. Anonymous: The effect of sulfur dioxide on man. USBMB 98:36, 1915.

Describes an experiment on 60 persons to determine what concentration of sulfur dioxide creates a nuisance. It is concluded that the average person is conscious of sulfur dioxide pollution at a concentration 3.5 parts per million but that "trained" persons are conscious of such pollution at 2.5 parts per million. Thus, sulfur dioxide is a nuisance to a community when its concentration is 3 parts per million or more. No mention is made of harmful concentrations and their effects. - BAAP

433. Anonymous: Atmospheric pollution and pulmonary diseases. British M. J. 1:227 (Feb.) 1931.

This is a report of 63 deaths in the Meuse Valley incident. Most of those who died were elderly and, in many cases, already suffering from cardiac and pulmonary disorders. Also, there were a misty fog and bitter cold weather to take into consideration. However, death appeared quickly, suggesting poisoning, and at autopsy, the lungs showed irritative changes consistent with the inhalation of sulfur dioxide. - BAAP

434. Anonymous: Sulfur - chief cause of fog deaths. Foreign Letters, J. A.M.A. 156:785, 1954.

This is a brief review of the Ministry of Health report. See: Ministry of Health: Mortality and Morbidity During the London Fog of December 1952, Report by a Committee of Departmental Officers and Expert Advisers appointed by the Minister of Health. Reports on Public Health and Medical Subjects, No. 95, H.M. Stationery Office, 1954, 61 pp. - KB

435. Anonymous: Sulfur dioxide in air adds to discomfort here. New York Times 7/23/55. Smog News No. 46:12, 1955.

"A large mass of warm air about 280 ft. above ground was blamed by experts at the Department of Air Pollution Control for a heavier-than-usual concentration of SO_2 around town. Many complaints of reddened, moist eyes were received during the morning. The department's instruments showed ca. .02 - .025 ppm SO_2. Ordinarily at this time of the year the ratio would be ca. .01 ppm. Air pollution spokesmen emphasized that SO_2 is a normal product of industrial combustion and that, during the winter, a considerably higher concentration is comfortably tolerated by metropolitan breathers. What caused the trouble yesterday, they explained, was an unfortunate combination of heat, humidity, fumes and air arrangement. Three Western Union messengers in Brooklyn were among the first to report back to their office that their eyes were affected seriously enough to interrupt their bicycle rounds." - KB

436. Baetjer, A.M.: Chronic exposures to air pollutants and acute infectious respiratory diseases. A.M.A. Arch. Indust. Hyg. Occupat. Med. 2:400-406 (Oct.) 1950.

Data obtained from studies of the health of persons who had been exposed to specific chemical contaminants of the air have not yielded any definite evidence that chronic inhalation of such chemical contaminants in low concentrations affects susceptibility to acute infections of the respiratory tract. Similarly, the few experiments which have been performed on laboratory animals have yielded chiefly negative results. However, it must be evident from this review that the data available at present are entirely insufficient to enable one to draw any definite conclusions. It is hoped that this brief review will emphasize the need for fundamental research on the subject along the following four lines: (1) basic studies on the physiologic effects of air pollutants on the body tissues, (2) animal experimentation on the effects of these substances on susceptibility to infectious diseases (3) industrial morbidity studies relation to known exposures and (4) well controlled epidemiologic studies. Not until such data become available can any positive statement be made concerning the effects of chronic inhalation of atmospheric contaminants on acute infections of the respiratory tract. - Authors' Sum.

437. Barnes, J.M.: Mode of action of some toxic substances. With special reference to the effects of prolonged exposure. British Med. J. pp. 1098-1104 (Oct. 28) 1961.

Intermittent or more continuous exposure to chemicals with a tremendous variety of biological properties is undergone by many people during their work in industry, their life in our cities, and even in the privacy of their homes. In some polluted atmospheres the quantities of toxic materials seem to border on those demonstrably hazardous. In others--for example, the field of food additives--most of the materials appear by current standards to be virtually harmless. In other situations, particularly where occupational exposure is concerned, the chemicals may produce some deviation from normal the significance and importance of which are at present not fully understood.

Unfortunately, there are only very limited resources available either in this country or overseas for the experimental study and proper analysis of the properties and mode of action of toxic substances. In recent years the balance of this effort has been grossly disturbed by the current clamour about the safety of chemicals used as food additives (Mulford, 1961). Increasingly greater laboratory facilities are being devoted to the carrying out of set procedures to show that substances almost biologically inert can be tolerated by rats and dogs for years on end. There are, however, still quite a number of really poisonous materials, particularly in the environment of those in certain occupations. It is surely important to see that, in this country at least, more attention will be paid to the problems presented by such materials.

438. Batta, G., Firket, J. and Leclerc, E.: Problems of atmosphere pollution. Masson et Cie., Paris, 1933.

The authors take up in detail all questions of air impurities. They consider the physical basis for atmospheric pollution, such as the causes and kinds of impurities, the products of combustion, and industrial contaminants. The effects of these impurities on man, as well as on plants, metals, and stone, are described.

One chapter is devoted to a description of the Meuse Valley disaster of December 1930. In this disaster 64 persons died, and a thousand were taken ill. The conclusion was reached that the cause was one of a peculiar meteorological situation plus sulfuric acid formed from sulfurous acids originating from the many industrial plants. Sulfuric acid was named as the chief cause for deaths and illness. Hydrofluoric acid from one plant was considered only a secondary factor. - BAAP

439. Bell, A.: The effect on the health of the residents of East Port Kembla. (Part II). In: Air pollution by metallurgical industries, by Bell, A., and Sullivan, J.L. Div. of Occupat. Health, New South Wales, Dept. of Pub. Health, Sydney, Australia, 1962, pp. 2:1-2:144.

A group of 947 residents of East Port Kembla were interviewed and asked for the information of a standardized questionnaire in order to determine the prevalence of chronic bronchitis. In addition, smaller numbers of people underwent pulmonary function and sputum tests. Individual findings for the regions of high and low pollution, areas "A" and "C" respectively, were compared to see if there were any statistically significant differences. Some of the more important of the findings were: From the standardized questionnaire it was learned that a larger percentage of people living in area "A" consider that they are suffering from either chronic bronchitis, or bronchial asthma, than is the case in area "C". Of the two diseases the prevalence of the former is nearly always the higher. Only a few people complained of symptoms unrelated to the respiratory tract. When the "fumes are bad" many people remain indoors. From the medical questionnaire it was learned that residents were specifically questioned to determine the prevalence of nasal catarrh, whether bad colds "settled on the chest", number of times they were confined to bed because of chest illnesses, wheeze, cough, phlegm, and dyspnea. With the exception of the prevalence of nasal catarrh among men, the percentages of people adversely affected by the individual symptoms was persistently higher in area "A" than in "C". The residents of area "A" seem to be exposed to some factor probably almost entirely absent in "C" but still present in area "A", though to a lesser degree. On the sputum tests, of the 333 samplings collected in East Port Kembla, 84.7% were mucoid and 15.5% were mucopurulent in character. In most areas a higher percentage of men were sputum-producing than were women. Only in 50% of the separate age groups studied was the result of the pulmonary function test lower in area "A" than in "C". A few people complained of hypersensitivity of their teeth, particularly when the "fumes were strong." The available evidence suggests that some external influence might be exerting a harmful effect on the gingival tissues of young people living in area "A". Out of the 947 people interviewed, 6.7% were diagnosed as having chronic bronchitis. In the case of both sexes, area "A" had a higher rate than area "C". As to what causes the difference between the two areas, it is difficult not to seriously consider the high peaks and known variations in the average concentrations of atmospheric sulfur dioxide. However, the author warns that it must not be assumed that this investigation has conclusively proved a cause and effect relationship between the prevalence of chronic bronchitis in East Port Kembla and atmospheric pollution. - APCA

440. Burn, J.L. and Pemberton, J.: Air pollution, bronchitis and lung cancer in Salford. Internat. J. Air & Water Poll. 7:5-16, (Jan.) 1963.

Daily measurements of smoke and sulfur dioxide pollution were made at five stations in Salford for the two years 1958-59. The measurements were used to define three groups of wards: "higher pollution", "intermediate pollution" and "lower pollution".

All Ministry of National Insurance certificates of incapacity from bronchitis issued to Salford residents over a two-year period were analyzed in relation to air pollution levels. Deaths in men aged 45-64 in Salford for the years 1956-59 from "all causes", bronchitis, lung cancer, arteriosclerotic heart disease and vascular lesions of the central nervous system were also analyzed in relation to air pollution levels.

In four out of five smog episodes during the period studied, the number of new spells of bronchitis increased more than two-fold.

The group of higher pollution wards showed higher bronchitis morbidity rates in men aged 45-64 than the other wards. - APCA

441. Cadle, R.D. and Magill, P.L.: Study of eye irritation caused by Los Angeles smog. AMA Arch. Indust. Hyg. & Occupat. Med. 4:74-84, 1951.

The mixture of atmospheric contaminants, known as smog, which plagues many populous areas has a number of unpleasant properties. One of the most exasperating of these is the eye, nose, and throat irritation which is often produced. Eye irritation (frequently accompanied by lacrimation) is perhaps the most outstanding characteristic of the smog occurring in the Los Angeles area. This property of smog has been studied in these laboratories for several years. No single contaminant thus far identified in Los Angeles smog accounts for the eye irritation, but artificially prepared mixtures of several contaminants in concentrations at which they exist in smog have been shown to produce significant irritation.

The purpose of the work described here was to determine the change in eye, nose, and throat irritation produced by systematically changing the composition of the artificial smog. Information reported by members of a test panel was treated by mathematical statistical methods in order to determine the significance of the differences produced by the various changes made in the composition of the test atmospheres.

442. Carey, G.C.R., Phair, J.J., Shephard, R.J. and Thomson, M.L.: The effects of air pollution on human health. Am. Indust. Hyg. A. J. 19:363-370 (Oct.) 1958.

In general, there are 2 ways in which the effect of reducing smog on man may be ascertained: (1) Studies of acute exposures in industry or in catastrophic episodes of urban air pollution. (2) Studies of chronic exposures. During 1955-56 3 pilot studies were undertaken in Cincinnati and all field work has been completed. The preliminary results of the 3rd survey are given. Cardiorespiratory cripples were selected since they were thought to be more susceptible than healthy individuals to the effects of smog and because, as a group, they tend to remain in the vicinity of their own homes in which air pollution measurements are being continuously recorded. Each was visited 3 times a week by a nurse who obtained the necessary clinical and environmental measurements. Outdoor air sampling stations were placed at 3 different areas of the town and serviced by a technician. Three sets of data were obtained in respect to each patient; (1) measurement of his complaints, (2) measurement of his reactions, and (3) measurement of his environment. Hourly measurements of smoke, temperature, and humidity were taken at outdoor stations and within the homes of patients in all 3 surveys, using sequence smoke samplers and thermohygrographs. About 110,000 observations of environmental conditions and patient reactions were obtained during the 3-month period of the 3rd survey. The results given are preliminary findings only and the conclusions may have to be modified when the analysis is completed. - APCA

443. Ciocco, A. and Thompson, D.J.: A follow-up of Donora ten years after. Methodology and findings. Am. J. Pub. Health 51:155-164 (Feb.) 1961.

Following the acute episode of air pollution in Donora, Pa., in Oct. 1948, the Public Health Service conducted a community survey on a systematic one-third sample of the households of Donora listed in the 1947 files of the tax assesor of the borough. Information was obtained on 4092 residents at that time. Early in 1957, by use of mailed questionnaires and personal interviews, slightly more than 99% of these same individuals were contacted and information was obtained on the 1957 prevalence and 1948-57 incidence of certain chronic conditions as well as on certain cardiorespiratory symptoms, hospitalization and medical services received, place and cause of any deaths, residence, occupation, smoking history, and other related information. Earlier data for these persons were not known by the interviewers in 1957. The essential findings of the follow-up study were that persons who reported acute illness at the time of the smog episode demonstrated subsequently higher mortality and prevalence of illness than did other persons living in the community at that time. Furthermore, persons who complained of more severe acute illness in 1948 demonstrated greater subsequent morbidity and mortality than persons with mild complaints, with some evidence in the data that this was related to the cardiorespiratory system. When persons who reported chronic cardiorespiratory illness which antedated the 1948 episode are removed from the comparisons, the differentials in subsequent illness experience between the acutely ill and those who did not experience illness, are narrowed considerably. Finally, no substantial or consistent relations between environmental variables and health experience could be demonstrated. Some of the questions arising from this study are discussed briefly. - APCA

444. Cooke, R.A.: Asthma in children; its cause and treatment. J. A.M.A. 102:664 (March) 1934.

This review of asthma has particular reference to the disease in children. Discussing nonspecific causes, the author considers exercise, eating, heat, humidity, and extreme cold not to be fundamental causes, but rather excitatory, precipitating an attack in an individual with an asthmatic predisposition or an asthmatic history. On clinical grounds, he believes that sulfur dioxide may be a specific precipitating cause of asthma. - BAAP

445. Daly, C.: Air Pollution and bronchitis. British M. J. 2:687-688, 1954.

An analysis by the Social Medicine Research Unit of the Medical Research Council of the relationship of SO_2 content of total solid matter to bronchitis similar to that of Pemberton and Goldberg (British M. J. 2:567-573, 1954) gave results that were in good agreement. However, PbO_2 instruments for measurement of SO_2 pollution were in use in only 15 county boroughs and $SO_4^=$, as a dissolved impurity in deposit gauges, was measured in only 24 county boroughs. The correlation coefficients obtained for males aged 45-64 for the years 1946-50 were r=0.51, using the 1st index of pollution, and r=0.32, using the 2nd. Because of the small number of stations and the considerable variation of results among closely located stations, a new measure of atmospheric pollution was chosen, the consumption of domestic coal/acre; this extended the study to all 83 boroughs in England and Wales. Though only preliminary investigations have been made, the coefficient of correlation between the average annual mortality from bronchitis in males 45-64 yrs. for 1950-2 and the consumption of domestic coal/acre in 1952 is 0.59; this is highly significant. Taking into account other variables, viz., social class and overcrowding, only reduced the coefficient to 0.52 and 0.53, respectively. When the consumption of all coal (except for railways and shipping) is correlated, the coefficient is only 0.24. Since SO_2 evolution from nondomestic coal/ton is about the same as for domestic coal, but smoke evolution is lower, it would seem premature to attribute the bad effects of air pollution primarily to SO_2. The correlation coefficient between domestic coal consumption and the death rate from "bronchitis and pneumonia" of females 45-64 yrs. for 1950-2 is 0.54. - KB

446. Daly, C.: Air pollution and causes of death. British J. Prevent. & Soc. Med. (London) 13:14-27 (Jan.) 1959.

For each of the 83 County Boroughs of England and Wales 2 sets of data have been calculated: (a) amounts of different types of fuel consumed, domestic and industrial, in or about the yr. May 1951 to May 1952 and related specifically to the built-up area of each town, and (b) death rates of men aged 45-64 yrs. in 1948-54 from bronchitis, lung cancer, other respiratory diseases, and all non-respiratory diseases. Calculation of correlation coefficients shows the highest degree of association with bronchitis followed by pneumonia, respiratory tuberculosis, lung cancer, and all non-respiratory diseases, in that order, all of which show a substantial association with domestic pollution. Diagrams specifically provided for bronchitis and lung cancer show a clear upward trend in the former with the pollution indexes but only a quite slight upward trend in cancer of the lung. Bringing indexes of social class into the picture suggests that not less than 1/3 of the variation in the bronchitis death rates would be attributed to air pollution and another 1/3 to social factors. Similar calculations for lung cancer, however, give no indication that air pollution is a major factor in its etiology. On the other hand, some data on present smoking habits give only slight differences between groups of towns differing considerably in their mortality. The source of the variation is therefore obscure. An attempt has been made to measure the effect of air pollution from sulfur products by studying the power stations in or near each town. The results give no reason to suppose that proximity to a power station has any noticeable effect on bronchitis mortality. - APCA

447. Davies, C.N.: Dust in the lungs. New Scientist (London) 11:782-784 (Sept.28) 1961.

In contrast to the digestive tract the lungs are much more subject to damage from toxic or other material. For this reason, apart from specific toxicological considerations, the permissible concentration of atmospheric contaminants is often about one ten-thousandth of the amount tolerated in drinking water, a figure which reflects the ratio of man's consumptions of water and of air. A quality of the lungs which makes them particularly vulnerable to airborne substances is the delicacy and extraordinary degree of development of the surface used for oxygen and carbon dioxide exchange. The area of the lungs is probably around 30 m.^{2} and the membranes and structures separating the air cavities from the blood stream are tenuous in the extreme. The lungs have efficient defenses against inhaled particles but can be overwhelmed by fine dust which inflicts severe or lesser damage according to its nature. The anatomical structure and functioning of the lungs are discussed in relation to the probability of the deposition of air-borne particles in the air spaces and the level of deposition, particularly in relation to the particle size. APCA

448. Davies, C.N.: Fog bronchiolitis. Lancet no. 7281:850-851 (March 16) 1963.

Case reports are given of 12 persons, with severe respiratory symptoms, who were admitted to Guy's Hospital during the period of fog of Dec. 4 to Dec. 7, 1962. Of this group, 9 patients who were chronic bronchitics presented the picture of acute bronchiolitis. Infection was notably absent, and measures known to relieve their bronchospasm in the past were ineffective. None improved while the fog was present, and all worsened abruptly during the early days of the fog. These facts, taken with the rarity of bronchiolitis in more clement weather, incriminate the fog as a cause. The mortality from the recent fog has been notably lower than from the 1952 fog. In Greater London out of 4703 who died in the week of the 1952 fog, 380 deaths were registered as being due to "influenza" and "pneumonia." In the comparable period in 1962 there were 1028 deaths, of which 201 were due to a respiratory cause. The composition of the two fogs has also been different. The earlier fog lasted rather longer, and the smoke content rose to a peak three times as great as was found in 1962. The sulfur dioxide content was very similar, but the exposure to this gas was longer in 1952 than in 1962. Reports published after the 1952 fog did not mention the syndrome of bronchiolitis. One author reported that rales were noted in some cases, especially after a few days' illness. In the 1962 group of patients, rales dominated the clinical picture. It seems possible that bronchiolitis did not occur in the 1952 fog. If bronchiolitis was a complication found in the fog of 1962 and not in the 1952 fog, the cause may lie not in the analysed fractions, but in some new and undetected constituent. - APCA

449. Dohan, F.C. and Taylor, E.W.: Air pollution and respiratory disease. A preliminary report. Am. J. M. Sc. 240:337-339 (Sept.) 1960.

A high correlation between the average concentration of an air pollutant (sulfates) and the incidence of respiratory diseases in women working in five cities has been demonstrated. This in association with other information suggests that susceptibility to or duration of some common respiratory infections is increased by exposure to the air pollutants measured as sulfates. - Authors' Sum.

450. Dohan, F.C., Everts, G.S., and Smith, R.: Variations in air pollution and the incidence of respiratory disease. J. APCA 12:418-422, 436 (Sept.) 1962.

There is a high correlation (r=0.96) between the mean concentration of suspended particulate sulfates in the city air and the incidence rates (means of three years) of respiratory disease lasting more than seven days in women working in five cities. The weekly Respiratory Disease Incidence Index (over a period of 61 weeks) for working populations located in the adjacent cities of Philadelphia and Camden exhibited in high correlation thus suggesting that a general environmental factor played a role. During the 15-month period of observation to date, the weekly means suspended particulate sulfate concentrations in outside air at a test site in Philadelphia declined to and reached its lowest value prior to the seasonal (spring-summer) decline in the weekly Respiratory Disease Incidence Index. At least several years of observation are needed to determine if there is a temporal relationship between fluctuations in the incidence of respiratory disease and fluctuations in air pollutants. The evidence from this and other reports indicates that further investigation should be made of the relationship of the absolute incidence of specific, and grouped respiratory diseases, and their duration, severity, and complications, to variations in concentrations of specific air pollutants and in weather parameters. - Author's Abst.

451. Faerber, K.P., Hoffman, A., and Schmitz, G.: Investigations concerning the evidence of harmful effects of air pollution on the health of man in larger population groups. Öffent. Gesundheitsdienst 20:493-511 (Mar.) 1959.

From the summer of 1957 to the fall of 1958, simultaneous measurements of the degree of air pollution in Oberhausen and in the counties of Empel-Rees and Geldern were carried out by the Inst. of Hyg. in Gelsenkirchen. Clinical examinations of residents of the areas were also made by the Dept. of Health in Oberhausen. Air pollution was, on the average, about 5 times as extensive in Oberhausen as in the counties. This could be related, to a certain extent, to the absorption of sunlight as was revealed in comparative measurements. Rickets was detected in the infants of Oberhausen twice as frequently as in the corresponding country children. In the 12-yr. old boys, serum phosphatase values were abnormally high in Oberhausen, but these findings could be established in Oberhausen only. The red blood count, in a total of more than 4000 specimens from male public school students, was significantly lower in Oberhausen. The particularly strong pollution of the atmosphere of the borough of Oberhaussen-Osterfeld appeared to be directly proportional to the very low blood counts and phosphatase values of the Osterfeld children. The 10-, 11-, and 14-yr. old children were found to be shorter in stature and lighter in weight in all the experimental groups in Oberhausen. The incidence of bronchitis in these children was almost 1½ times, and that of eye injuries and inflammations almost 4 times as frequent as in the country. On the other hand, skin injuries were observed somewhat more frequently in the country. Frequency of bronchitis among the adults of Oberhausen was 10% above the average number in the counties. Eye injuries and inflammations in adults were observed twice as frequently in Oberhausen. It was concluded that air pollution can be held responsible for the occurrence of certain pathological changes in humans in proportion to its specific action. The authors note that it is impossible, using the methods at their disposal, it assess precisely in all instances the extent to which injuries were caused by air pollution. - APCA

452. Firket, M.: The cause of the symptoms found in the Meuse Valley during the fog of December 1930. Bull. Royal Acad. Med. Belgium 11:683, 1939.

Certain symptoms common to all were painful irritation often mounting to an active retrosternal pain, and extending along the outer edge of the ribs; attacks of coughing, dyspnoea, often paroxysmal; and prolonged expiration. Adrenalin often gave relief. Those previously affected with asthma or heart disease developed symptoms of shock. In addition to the tracheobronchopulmonary irritation, a large number showed signs of laryngeal irritation causing cough and modification of the tone of the voice. There was also some nausea and vomiting, lacrimation, and tenacious sputum. In one case there was desquamation of the mucosa of the entire buccal cavity. There was no diarrhea, neuritis, albuminuria, hepatomegaly or sensory disorders. "There is no reason to believe that only the ill and the aged were seriously affected by the toxic attacks. Persons were attacked who had not left their houses for several weeks or who had not gone out in the fog. At autopsy there was congestion of the mucous membranes of the air passages. All the symptoms and all the lesions found could be sufficiently explained by a local irritation of the exposed mucous membranes. - APCA

453. Firket, J.: Fog along the Meuse Valley. Trans. Faraday Soc. 32:1192, 1936.

Between December 1 and 5 of 1930, a heavy fog covered a large part of Belgium. A number of people were made ill; several hundred were severely attacked with respiratory symptoms, and 63 died on December 4th and 5th after only a few hours of illness. Many cattle had to be slaughtered. On December 6, the fog disappeared. Public opinion was deeply affected by the episode, and an investigation was started immediately. All the sick people felt retrosternal pain, had fits of coughing, and dyspnoea, and some had asthmatic attacks. In those who had asthma, cardiovascular collapse and symptoms of shock complicated the picture. In those who did not have asthma, hyperpnea, cyanosis and a tendency to frothy sputum developed. The autopsy reports indicated that the noxious substance was inhaled during the last few hours of life. The first symptoms began on the third day of the fog. Respiratory symptoms disappeared on the sixth day when the fog abated. Symptoms were observed by the people throughout the valley at about the same time. Chemical Analyses: The chemists found thirty substances polluting the atmosphere, with maximum concentrations reached by carbon monoxide, carbon dioxide, nitrous gases, sulfur dioxide, and hydrogen fluoride. Through deduction, observation, and data obtained, sulfur dioxide appeared to be issued in the largest amount in the whole valley as a result of burning coal. Part of the sulfur dioxide was oxidized into sulfuric acid. Only by the action of sulfur pollution could the simultaneous illnesses occurring along the entire valley be explained. The pathological findings also favored sulfur dioxide and sulfur trioxide as the offending gases. - APCA

454. Fletcher, C.M.: Disability and mortality from chronic bronchitis in relation to dust exposure. AMA Arch. Indust. Hyg. 18:368-373 (Nov.) 1958.

Bronchitis is an important cause of morbidity and mortality in the working classes in Great Britain. Evidence is presented that atmospheric pollution by coal and tobacco smoke and by industrial dusts is concerned in causation. Morbidity surveys suggest that the relationship of bronchitis to dust exposure is complex. Surveys of respiratory morbidity in workers exposed to respiratory irritants and in control groups in Great Britain and in the U.S., where bronchitis may be less prevalent, could help to elucidate this important problem to industrial health. - APCA

455. Fletcher, C.M.: Chronic disabling respiratory disease: Ends and means of study. California Med. 88:1-11 (Jan.) 1958.

In the program of research into the natural history of coalworkers' pneumoconiosis now being carried out in Great Britain, emphasis is being put upon the importance of sharpening and validating means for early diagnosis, and upon the need for follow-up studies upon properly selected population samples. Existing information from morbidity and mortality figures from chronic bronchitis and emphysema in Great Britain suggests that atmospheric pollutants are important etiological factors. A parallel is drawn between the course of events in pneumoconiosis, in which dust retention in the lungs does not greatly disable until complicated by tuberculous infection, and a hypothesis that bronchitis is a hypersecretion of bronchial mucus caused by atmospheric irritants and does not disable but encourages secondary infection which may cause emphysema. This hypothesis requires testing by follow-up studies of population samples exposed to various environmental influences. It is suggested that in order to bring this common and disabling disease under control, clinicians must widen their interests beyond the confines of the hospital walls. - APCA

456. Fletcher, C.M.: Chronic bronchitis: Its prevalence, nature, and pathogenesis. Am. Rev. Resp. Dis. 80 (Part I) 483-494 (Oct.) 1959.

Mortality from bronchitis in England and Wales is about 45 times greater than in the U. S. Although some of this excess mortality may be due to differences in diagnostic custom, much of it must be real. At present there is considerable confusion over the use of the words bronchitis, asthma, and emphysema. No strictly comparable morbidity statistics are available but there is some evidence that the disease may be common in the U. S. in a less disabling form than in Great Britain. In summarizing his views of the pathogenesis of chronic bronchitis the author suggests that atmospheric irritants, including cigarette smoke, produce bronchial hypersecretion in susceptible subjects. And that in some of these, especially in the poorer sections of the population exposed to atmospheric pollution or dusty working environments, secondarily recurrent or persistent infection develops and leads to disability from bronchial obstruction and ultimately to pulmonary emphysema. Two important facts remain unexplained: the reason for the steep social-class gradient in morbidity and mortality, and the excessively high mortality in Great Britain compared with other countries and especially with the U. S. It is not yet know whether the prevalence of simple bronchitis is much higher in Great Britain than elsewhere. - APCA

457. Gervois, M., Voison, C., Salmon, A., Fournier, P., and Leduc, M.: Rev. Hyg. Med. Soc. 11:213-217 (April-May) 1963.

It is possible to indicate the pathogenetic action of atmospheric pollutants--at the percentage levels at which they can be found in the atmosphere of cities--through physico-pathological studies of animals and humans. The morbidity caused by chronic respiratory infections, especially that in chronic bronchitis, is greatly increased in areas of high urban density, as the authors have found in the north of France where there is a high level of industrial pollution. The factors that intervene in the complex pathogenesis of these infections are numerous, but the findings made up to the present time agree sufficiently to justify the methods of fighting against all the causes of pollution of the urban atmosphere, as well as the maintenance of the green belt in town and country. - APCA

458. Goldsmith, J.R.: Effects of air pollution on man. Connecticut Med. 27:455-464 (Aug.) 1963.

Pollution may arise from many sources but to simplify the presentation the author considers only those arising from motor vehicles and from heat and power production. It is these activities which are most frequently a source of difficulty and require policies which affect wide areas of the country. The author discusses briefly the effects of motor vehicle contaminants and lists the following exhaust ingredients as likely to affect the public health: aldehydes, CO, some of the hydrocarbons, oxides of nitrogen, lead compounds, and SO_2 with the latter depending on the sulfur content of the fuel. Currently many studies are being done using an epidemiological approach to study the processes which affect the health of groups of people. This approach is largely nonexperimental. More recently, experimental human exposures have been undertaken and the relationship between experimental studies and epidemiological studies should become more intimate as research progresses. Some air pollutants, and their mode of action are discussed: acrolein, formaldehyde, lead, the photochemical mixture, ozone, and nitrogen oxides. Based on the association of eye irritation and oxidant, the present air quality standard for the photochemical complex was established in 1959 as 0.15 ppm. A serious deficiency in our knowledge at the present time concerns whether photochemical pollution products can cause lung cancer or chronic lung disease. A major category of pollutants are the oxides of sulfur, together with droplets of soot and several of the hydrocarbons, which are emitted from either power plants burning coal and fuel oil or from homes especially those heated by coal or oil. There is a brief discussion of the implications of the foregoing information on the care of patients. - APCA

459. Gore, A.T., and Shaddick, C.W.: Atmospheric pollution and mortality in the County of London. British J. Preventive & Soc. Med. 12:104-113 (April) 1958.

An examination of mortality experienced in London during periods of fog in association with indices of atmospheric pollution suggests a critical level of four times the customary winter average of atmospheric pollution above which a fog will cause marked immediate excess mortality.

By the methods used in this investigation no significant relationship between mortality and exposure to smoke and sulfur dioxide was demonstrated over a 2-year period. A critical level of one or both in combination that would be directly associated with increased mortality is not thereby excluded. There may also be other types of pollutants more dangerous than either. Living in London for a long period is considered to increase the risk of dying from respiratory disease, particularly bronchitis. A crude index, percentage born in London, had perforce to be used as a measure of length of residence. If the Clean Air Act 1956, has the effect of reducing the amount of smoke in the atmosphere it may be possible to assess with greater clarity the respective parts played by sulfur dioxide and smoke. - Authors' Sum.

460. Gorham, E.: Bronchitis and the acidity of urban precipitation. Lancet 275:691 (Sept. 27) 1958.

It has been conjectured that air pollution is at least partly responsible for the uncommonly high incidence of bronchitis in Britain, especially in urban areas during the winter. In this paper the author reports a correlation between bronchitis mortality and the acidity of urban precipitation. The mortality rates for bronchitis were calculated from the Registrar General's annual statistical reviews for the whole population of 53 county and metropolitan boroughs in England, Scotland, and Wales over the 5-yr. period 1950-54. These were plotted against air pollution data from single stations and periods within these boroughs. The latter data were obtained from a table of the 27th report (1955) of the Dept. of Scientific and Industrial Research on the investigation of atmospheric pollution, which gives monthly figures for various pollutants as well as the pH of the precipitation. The average, as plotted logarithmically, of the annual urban death rate from bronchitis was 82/100,000 persons or about 1.8 times the rural death rate for the same period. In those areas where rain pH was well below 4, and hence strongly acid, the death rate reached 100 while it was only about 60 in those urban areas with the least acid rainfall. The rural death rate was considerably lower, at 46/100,000 of population; acidity would not appear to be the only factor involved in the increased urban death rate. Although such an interpretation must be regarded with caution, it seemed not unreasonable to infer that long-continued exposure to acid aerosols might increase the likelihood of bronchial inflammation. It was mentioned that in the English Lake District the rain pH averaged 4.5 owing to the pollution of the air with sulfuric acid borne on the easterly winds from the great industrial areas. However, in the areas themselves hydrochloric acid would seem to be the chief cause of low pH values. - APCA

461. Gorham, E.: Pneumonia and atmospheric sulfate deposits. Lancet pp. 287-288 (Sept. 5) 1959.

The author reports on the results of a study correlating pneumonia mortality with sulfate deposits from the air in population groups of 53 counties and metropolitan boroughs in England, Scotland, and Wales. The statistics were taken from the Registrar General's annual statistical reviews for the 5-yr. period 1950-54, and from the 27th Report (1955) of the Department of Scientific and Industrial Research on the investigation of atmospheric pollution. From this study it was shown by the curves which were plotted from the data that the logarithmic urban death rate was 51/100,000 persons/yr. or about 30% higher than the rural death rate of 39. In Britain the rural population is also subjected to air pollution with the average sulfate deposit in areas outside the main centers of population and industry being about 50 g./100 m.^{2}/month. This is a whole-year average since the winter and summer values are quite similar. However, the sulfate figures used in the study were those of the winter months of Sept. to March when air pollution is usually much worse than in summer. Meetham (1950) estimated that the average life of a sulfur dioxide molecule in the air was about 12 hr., by which time it may well have traveled far from its urban point of origin. Another earlier investigation by the author (abstr. no. 2711) using statistics from the same sources, had shown a highly significant correlation between bronchitis mortality and the pH of precipitation in these same districts. Pneumonia mortality, however, showed no apparent correlation with rain pH, nor, after partial correlation, did bronchitis mortality show a significant correlation with sulfate deposit. The reasons for these findings are obscure, but it seems possible that the aerosol droplets carrying the hydrogen ions are deposited in the bronchi, and do their damage there, while the sulfur, in the form of gaseous sulfur dioxide, penetrates farther and exerts its deleterious effect in the lungs themselves. - APCA

462. Greenburg, L., Jacobs, M.B., Drolette, B.M., Field, F., and Braverman, M.M.: Report of an air pollution incident in New York City, Nov. 1953. Pub. Health Rep. 77:7-16 (Jan.) 1962.

An incident of increased air pollution occurred in Nov. 1953 in New York City. First indications began to appear on Nov. 18th with the recording of a considerably greater concentration of SO_2 in the air over that of the previous day and above the range considered normal for New York City. Also calls, originating from all sections of the metropolitan area, began coming in to the New York City Dept. Air Poll. Control to report eye irritation and coughing. This anticyclonic condition associated with temperature inversion dominated the area from Nov. 12th to 21st. A study of mortality data for New York City disclosed a statistically significant increase in the number of deaths from Nov. 15th to 24th. This increase apparently was generally distributed over all age groups. - APCA

463. Greenburg, L., Field, F., Reed, J.I., and Ehrhardt, C.L.: Air pollution and morbidity in New York City. J. AMA 182:161-164 (Oct. 13) 1962.

In an earlier publication (Greenburg, L., et al.: Report of air pollution incident in New York City, November 1953. Pub. Health Rep. 77:7-16 (Jan.) 1962, a period of high air pollution in New York City in November 1953, was related to increased mortality. A study of pediatric and adult clinic visits during this period of air pollution discloses an increase in upper respiratory illnesses and cardiac visits at all of the 4 hospitals studied. This increase was found to be statistically significant at 3 of the 4 hospitals for upper respiratory infection and in 2 of the 4 hospitals for cardiac illnesses.

The present study failed to reveal any effects of air pollution on the number of asthma clinic visits at any of the 4 hospitals studied during this November air pollution incident.

Based on the findings in this study in an effort to learn more about the effect of air pollution on health, it appears that clinic visits for upper respiratory illness and cardiac illnesses constitute a promising source of data. - Authors' Sum.

464. Heimann, H.: Air pollution and respiratory disease. Ann. Allergy 21:396-407 (July) 1963.

We believe that air pollution, as it exists in some of our communities, contributes significantly as a cause or aggravating factor of the following medical conditions: (1) acute respiratory infections, (2) chronic bronchitis, (3) chronic constrictive ventilatory disease, (4) pulmonary emphysema, and (5) bronchial asthma. We recognize that the data on which we have reached these conclusions are not complete.

We started our work only a few years ago with a few facts and many surmises and hypotheses. We think we know a great deal more now; but there is a great deal that we still do not know. We hope to continue to study the problem and to find out more to the end that we shall have better reason than we have even now for the control of air pollution to protect man's health. - Author's Sum.

465. Hemeon, W.C.L.: The estimation of health hazards from air pollution. Arch. Indust. Health 11:397-402, 1955.

Solid aerosols are the only community air pollutants of significance in affecting human health (except perhaps SO_2). The sampling of these particles is difficult in that the larger size particles which are irrespirable are usually also collected, but exert only a diluent effect, thus giving erroneous compositions. Filter paper sampling which measures the amount of pollutants by the extent of light transmission is more informative, since the finer particles only are responsible for the scattering of light. This method should be useful in chronic exposure studies.

Some 50-75 g. of smog solids from the week of the severe smog in Donora (1948) were obtained from a home electronic air filter. A partial analysis of these solids showed 40% C, 10% S (as SO_3), 9.7% Zn (ZnO) and lesser amounts of other constituents. Spectrographic analysis for metal showed very low %'s for metals with Fe, Al and Si 5-15%, and Zn, Ca and K 1-10%, the rest being less than 1%. Upon calculation of the adsorptive power of the particles, it was found that the amount of SO_2 possibly transported would = 0.1-0.2 cc./24 hrs., thus lower than irritating value. However, examination of the H_2O soluble fraction (22%) of these solids chemically and by X-ray diffraction disclosed large quantities of $Zn(NH_4)_2(SO_4)_2 \cdot 6H_2O$ and $ZnSO_4 \cdot H_2O$ to be present. The solids removed from an air-cleaning filter in London for the mo. of Dec. '52 in which the severe smog occurred was also obtained and examination showed that 30% by weight was soluble/H_2O and rich in S (21% as SO_3), NH_3 and CL^-'s with appreciable amounts of Na, K, Al, and Mg. X-ray diffraction analysis showed principal constituents to be NH_4Cl and $CaSO_4$.

The sulfates and chlorides of NH_3 are known to be respiratory irritants and are believed to be the significant irritants of the 2 smogs. The SO_2 in the atmosphere in smog seems to be significant only in its formation of sulfates. All the constituents of these salts, i.e., NH_3, S, Cl^-'s and the various metals are common in coal smoke.

Though both of these samples collected are probably not representative of the respirable particles, the results obtained are considered to be of qualitative, if not of quantitative significance. - KB

466. Hine, C.H., Hogan, M.J., McEwen, W.K., Meyers, F.H., Mettier, S.R., and Boyer, H.K.: Eye irritation from air pollution. J. APCA 10:17-20 (Feb.) 1960.

Eye irritation remains one of the major demonstrable ill effects of community air pollution. Experimental work reported in this paper does not demonstrate any objective evidence of histologic or biochemical change following exposure to relatively high concentrations of single or combined pollutants or artificial smogs. Measurements using human panels, by a number of groups, have contributed to a further understanding of the factors which lead to the formation of the eye-irritating components of polluted air, even though these have not as yet been identified. - Authors' Sum.

467. Jacobs, M.B., Goldwater, L.J., and Fergany, A.: Comparison of suspended particulate matter of indoor and outdoor air. Internat. J. Air & Water Poll. 6:377-380 (Sept.-Oct.) 1962.

Suspended particulate matter was determined at 21 locations for indoor and outdoor atmospheres. The indoor samples ranged from 90-957 with an average of 284.8 $\mu g./m.^3$, but if 4 factory locations are omitted the indoor samples ranged from 101-424 with an average of 243.6 $\mu g./m.^3$. These values are in agreement with other work in this field. There was some indication that carpeted rooms are dustier than uncarpeted rooms but statistical evaluation does not show a significant difference. - APCA

468. James, H.A., Zippin, C., and Meyers, G.E.: The recovery of aerosolized bacteria from humans.
II. Estimation of number of samples necessary for specified assurance of detecting exposure to an indicator organism. Arch. Environ. Health 2:391-396 (April) 1961.

Conservative estimates of the probability of recovery after exposure to specified numbers of organisms under varying conditions of exposure and delay in sampling were calculated from the experience with 91 men. These estimates formed the basis for graphs which provide guides to the number of samplings required to detect exposures under specified conditions with specified degrees of confidence corresponding to a range of theoretical probabilities of recovery in a single sample. - Authors' Sum.

469. Kaipainen, W.J.: Hydrogen sulfide intoxication. Rapidly transient changes in the electrocardiogram suggestive of myocardial infarction. Ann. Med. Internae. Fenniae 43:97-101, 1954.

This paper deals with a case of hydrogen sulfide intoxication contracted when shoveling manure. Convulsions typical of hydrogen sulfide intoxication and rapidly transient changes in the different organs followed. Changes reminiscent of myocardial infarction were found on the electrocardiogram. The changes were most marked two days after the intoxication had occurred and disappeared after a few days. Kidney lesions were also obvious as nonprotein nitrogen rose to 90 mg. per 100 cc. and the sediment showed red cells and hyalin cylinders. A month and a half later the patient felt well, apart from slight dizziness.

470. Karn, F.S., Shultz, J.F., Kelly, R.E., and Anderson, R.B.: Hydrogen sulfide poisoning of nitrided and carbided iron catalysts in the Fischer-Tropsch synthesis. Indust. & Eng. Chem. 3:33-38 (March) 1964.

Sulfur poisoning of iron Fischer-Tropsch catalysts was investigated because synthesis gas prepared by gasification of coal contains sulfur compounds. The poisoning of fused iron oxide catalysts converted to Hägg carbide by H_2S in 1 H_2 + 1 CO feed gas was qualitatively similar to the poisoning of the corresponding reduced catalyst; however, the carbided catalyst required about twice as much sulfur as the reduced sample for poisoning to the same extent. For catalysts converted to epsilon iron nitride, the activity decreased less rapidly with sulfur fed to the catalyst than with reduced or carbided catalysts. When temperature was increased to compensate for loss in activity, moderately long tests at constant productivity were possible.

Catalysts used in tests in which operating temperatures exceeded 300°C. were less oxidized than the same catalysts in synthesis tests at 250° to 260°C. In the high temperature poisoning tests, nitrided catalysts were partly converted to Hägg carbide. - Authors' Abst.

471. Kettner, H.: Maximum ambient air concentrations of harmful substances. Staub 21:527-529 (Dec.) 1961.

In taking the example of the max. permissible SO_2 concentrations in atmospheric air it has been possible to show that the values can vary depending on the basis of standards. Very strict requirements are laid down in the Soviet Union where such concentrations are permissible as produce no indication of change in the organism. While in the German Federal Republic and the Soviet Union 2 relatively low concentrations have been derived, 1 for short-term and the other for long-term concentration. Higher concentrations are permitted in the U. S., but these are limited by correspondingly shorter times. The American standard also provides for special daily concentrations. - APCA

472. Keyes, D.B.: Pure air for our cities. Scientific Monthly 35:427, 1932.

A discussion is presented to the effect that sulfur of coal produces sulfur dioxide and that this in turn produces sulfur trioxide, which with water forms sulfuric acid. It is the sulfuric acid which the author believes causes the injurious effects on people. Ways and means of eliminating sulfur dioxide from the flue gas and coal before burning were devised and are discussed in detail. - BAAP

473. Kisskalt, K.: The influence of the inhalation of sulfurous acid on the development of pulmonary tuberculosis. Z. Hyg. Infektionskrankheiten 48:269-270, 1904.

Rabbits were exposed to the inhalation of SO_2 in the air before and after being infected with t.b. bacilli. Controls were provided for both inhalation and infection alone. In preliminary exposures, the inhalation of 300 ppm SO_2 was tolerated by the author for only a short time (not specified), while the severe irritating effects of 1,500 ppm made breathing impossible. A rabbit inhaling 730 ppm of SO_2 in the air for 9 hr. sat motionless and demonstrated anorexia but rapidly recovered after the termination of the exposure, the only remaining effect being opaqueness of the cornea subsiding one day later. The experimental SO_2 concentrations (those usually occurring in industrial exposures), inhaled for 9 hr./day, ranged from 50 to 76 ppm, with the exception of 170 ppm (accidentally) for one day (8th). 6-wk. old human t.b. bacilli in 0.5 cc. salt solution, grown on Hesse's agar (coagulated cattle serum with no sugar added) without animal passage, were intravenously injected as follows: a) 0.066 mg. on the 6th inhalation day, b) 0.13 mg. on the 2nd; 5-wk. old t.b. bacilli of the same strain with animal passage were inhaled by the experimental rabbits (and the t.b. controls) on the 4th day. The body weight of the rabbits ranged from 1240 to 2450 g. The results may be summarized as follows: there are considerable differences as to the susceptibility to and resistance against the action of inhaled SO_2 in the rabbits, e.g., one tolerated 730 ppm for 9 hr. without showing any injurious effects, others tolerated 70 ppm but died when exposed for 9 hr. to 170 ppm SO_2. In 4 out of 5 experimental rabbits, the inhalation of SO_2 accelerated and exacerbated the course of t.b. which was demonstrated by severe gaseous pneumonia, by the greater size of the tubercles and by the occasional presence of tubercles in kidneys, liver or spleen as well as by some effects on the bronchi. The inhalation of SO_2 produced a predisposition for the development of t.b. in the exposed rabbits. This predisposition may be anatomical in nature (injury of the protective cell layer of the body surface skin which allows the microorganisms to penetrate) or may be due to effects on the physiologic or physicochemical defense mechanism of the organism. The SO_2 affects the blood and is probably injurious also to the other protoplasm. According to the difference in nature of t.b. between man and rabbit, the effects of the described exposure will be more pronounced in humans than in the animals.

Ranges of days between beginning of experiment and death (d- died, k- killed)

exposures	experimental rabbits	controls for tuberculosis	controls for SO_2
a)	10 (d) - 71 (d)	8 (k) - 65 (k)	11 (d) - 71 (k)
b)	62 (d) - 65 (k)	64 (k)	
c)	41 (d) - 58 (k)	38 (k) - 55 (k)	

KB

474. Kononova, V.A., and Aksenova, V.B.: Atmospheric air pollution with discharges from a synthetic alcohol plant and its effect on morbidity, sanitary and living conditions of the population. Gig. i Sanit. 26:3-7 (Sept.) 1961.

The investigations were aimed at determining the extent of the zone affected by the discharges from a synthetic alcohol plant and the effect of these discharges on the sanitary and living conditions of the population and on the morbidity rates. The results obtained show that, within 300 m. of the plant, the atmospheric air was polluted with hydrocarbons, sulfur dioxide, and hydrogen sulfide at averages of 184.5 mg./m.^{3}. 6.51 mg./m.^{3}, and 0.09 mg./m.^{3}. Even at a radius of 3000 m., or 3 km., there was still evidence of pollution by hydrocarbons (3.1 mg./m.^{3}) and sulfur dioxide (0.23 mg./m.^{3}). The data on children's morbidity rates during 1957, 1958, and 1959, indicate that the disease incidence among children living in the close vicinity of the plant was considerably greater than in those from the control group. For the yr. 1957 these figures, for 100 children, for the polluted area were 59.69 in contrast to the control area with 16.57. For 1958 the comparable figures were 53.8 and 26.98, and for 1959 were 31.7 and 19.20. - APCA

475. Lawther, P.J.: Some analytic and clinical methods in the study of atmospheric pollution. Instrument. Pract. (London) 11:611-615 (June) 1957.

Brief mention is made of sulfur dioxide determination by the lead peroxide and volumetric methods. The use of patients with chronic bronchitis as instruments to determine the circumstances responsible for the deterioration in their condition is described. - APCA

476. Lawther, P.J.: Climate, air pollution and chronic bronchitis. Symposium on Weather and Disease. Proc. Royal Soc. Med. 51:262-264 (April) 1958.

The degree of illness is seen to be more closely related to pollution than to any other factor during the winter months but this connection disappears when pollution falls in the spring. It is noteworthy that decreases in visibility do not always correspond to a worsening of the condition of the group and this strengthens the suspicion that fog itself may play a less important part than was formerly thought. These results do not imply any direct causal relationship between smoke and SO_2 and the clinical state of the patients, but show that pollution, of which these substances are at least indicators, is probably causally involved. The scheme has again been extended and further analytical data, including sulfuric acid measurements, are being collected. The interpretation of these results is as yet very incomplete, but they provide for the first time evidence that chronic bronchitis is influenced markedly by day-to-day variations in urban atmospheric pollution.

477. Lawther, P.J.: Some analytical and clinical aspects of British urban air pollution. Nat. Acad. Sc. - Nat. Res. Council PN 652, 1959, pp. 88-96.

The problem of the effects on health of polluted air must be broken down into its constituent parts which separately require for their elucidation the application of different techniques. The chemical composition and physical structure of acute pollution must be sought to enable the intelligent planning of experimental work on its effects; the aim is to indict specific pollutants and suppress their emission or to develop means of protection against them. Physiological experiments in which subjects are exposed to selected ingredients under controlled conditions have limitations which must be acknowledged in the interpretation and application of results. The experimental and epidemiological methods are of great complementary value. - APCA

478. Lawther, P.J. and Waller, R.E.: Atmospheric pollution and lung cancer. Trans. A. Indust. M. Officers 9:5-8 (April) 1959.

Deaths from lung cancer in England and Wales have increased steadily from 3432 in 1936 to 8110 in 1946, and to 18186 in 1956. Reasons for suspecting that air pollution may cause cancer are that urban air contains substances, especially 3,4-benzpyrene, known to be carcinogenic, and the disease occurs more often in towns than in the country. There are other carcinogenic substances in town air, among them 1,2-benzanthracene; 1,12-benzpyrene; benzene; chrysene; epoxides, and arsenic. More carcinogens in the air undoubtedly await identification but, for the present 3,4-benzpyrene claims attention because of its ubiquity and known potency. Extrapolation from animal experiments is dangerous since it cannot be assumed that the substance necessarily causes lung cancer in man. A high urban to rural ratio of lung cancer incidence in Norway has been shown despite a very low level of air pollution. There is direct evidence that living in large towns can provide an additional risk of lung cancer for non-smokers. The diesel engine is a new source of air pollution but it has not been used long enough to have been responsible for the increased incidence of lung cancer. Investigations in the London Transport bus garages showed that on a winter's night the concentration of 3,4-benzpyrene was much the same inside as outside. On a fine clear night in early summer it was found that the buses could be adding some benzpyrene to the air but less than 1/10 of that found in the outside air in winter. Medical examinations of the workers failed to show any excessive incidence of lung cancer such as would be expected if diesel fumes were a serious contributory factor. The authors conclude that cigarette smoking is a factor of overwhelming importance in the matter of lung cancer and that air pollution plays a role of minor significance. - APCA

479. Lawther, P.J., Martin, A.E. and Wilkins, E.T.: Epidemiology of air pollution. WHO PHP 15, Geneva, 1962.

Air pollution is a most important environmental evil in Europe, causing much preventable sickness and premature death. In many of those areas of Continental Europe where measurements of sulfur dioxide and suspended matter have been made, the recorded levels of pollution by one or both of these agents have been comparable with those noted in the United Kingdom, where a relationship between these pollutants and respiratory disease has been demonstrated. It is therefore possible, or even probable, that the health of urban populations in many European countries is being adversely affected in a similar way. Further investigations are needed in all European countries to determine the nature and extent of the air pollution to which their populations are exposed, including the estimation - in addition to the pollutants commonly measured -- of carbon monoxide, sulfuric acid, lead compounds, oxides of nitrogen and benzpyrene. Epidemiological studies provide the best means at present available for studying the influence of air pollution on health. In the planning and execution of such studies it is important that medical and chemical experts should co-operate so as to ensure that observations of pathological effects are matched by the fullest possible information on the air pollutants most closely related to those effects. Convincing evidence of the effects of specific air pollutants may be obtainable from internationally co-ordinated investigations carried out under varying climatic and environmental conditions.

480. Lawther, P.J.: Compliance with the Clean Air Act: Medical aspects. J. Inst. Fuel (Aug.) 1963, pp. 341-344.

The implementation of the Clean Air Act is discussed. It is hoped that this law will lead to the abolition of smoke. The carcinogenic nature of smoke is harmful to the health of man and its elimination must be hastened. The effects of the oxides of sulfur on man in concentrations as prevalent in urban areas are difficult to determine. Laboratory experiments with SO_2 have so far failed to produce measurable effects in concentrations less than 2 ppm. Experiments with realistic concentrations of sulfuric acid have been negative. Epidemiological studies on large groups have shown that the prevalence of bronchitis is closely associated with air pollution and that mortality and morbidity varies closely with changes in smoke and SO_2. It is pointed out that SO_2 must still be regarded as an indicator of air pollution rather than a proved cause of disease. Synergistic action of SO_2 and "inert" particles are discussed.

481. Lewis, R.: Epidemic asthma in New Orleans. A summary of knowledge to date. J. Louisiana State M. Soc. 115, 300-3 (Sept.) 1963.

In the 1st yr. of this continuing study of the epidemic attacks of asthma in New Orleans, it was determined from analyses of admission to Charity Hospital Emergency Center that there was indeed evidence of true outbreaks of common etiological origin. There was found to be no evidence of common exposure to people, place, or things. There was, however, evidence that the outbreaks were related to the speed and direction of the wind. A system of air sampling, for particulate substances, was set up and about 50 specific identifiable particles were classified for counting on a day-to-day basis. Of these particles, 1 was found to have a distinct relationship in time with the number of admissions to the hospital and subsequently was found to be related to the times of onset of asthma in a group of 150 persons, who were under nursing surveillance in their homes. The index substance is a poor combustion product in and around which are associated small crystals of silica. The substance was found in greater amounts at the time of increased reporting of attacks and found not to be abundant when the reported attacks were low in number. The only location with an abundant amount of the index substance was found to be the Agriculture St. city dump. The hospital admissions for asthmatic attacks and the number and time of calls by the fire department to the dump, were found to be closely related. Aqueous extracts of 17 different samplings from the smoke plume of the Agriculture St. dump were prepared. In tests with these extracts, positive responses were shown to 1 or more of the antigenic substances at a level of 80% in a group of city residents who had been involved in previous asthmatic outbreaks. A group of students with a previous history of asthma but with no current attacks gave a 50% response to 1 or more extracts; those students who were currently having asthmatic attacks gave a 75% response. For city residents with no history of asthma there was a 20% response to 1 or more extracts; for students without symptoms the level was 25%. - APCA

482. Logan, W.P.D.: Mortality from fog in London. British M. J. 1:722-723 (March 31) 1956.

Dense fog during January 4 to 6, 1956, caused almost 1000 additional deaths in London. This figure was derived by 2 methods, and other possible causes are considered and eliminated. The greatest excesses in deaths were among the elderly and the new born.

It is indicated that bronchitis was the principal cause of the excess deaths, especially among the aged. The geographical distribution of the deaths is described. This is the third major fog mortality incident in London since 1948. - APCA

483. Mage, J. and Batta, G.: Expert findings on the cause of the accidents that occurred in the Meuse Valley during the fogs of December 1930. Chimie et Industrie 27:961 (April) 1932.

This report covers many phases of the Meuse Valley incident, including a section on the medical findings.

It appears that most of the ill persons were elderly and included a large number of asthmatics and cardiacs. There was some illness among healthy adults and children. Deaths were generally ascribed to cardiac failure. Autopsies showed a diffuse congestion of tracheal mucosa and large bronchi. Soot particles were observed free in the pulmonary alveoli.

There is a section which discusses the possible causative agent in the episode and the conclusion is reached that it was most likely compounds of sulfur, especially sulfur dioxide. - BAAP

484. Magill, P.L.: The Los Angeles smog problem. Indust. Eng. Chem. 41:2476-2486, 1949.

The most disagreeable aspect of smog to the Los Angeles public is eye irritation. The records do not show that the Los Angeles climate has changed in recent years, although the average visibility is now not as good as prior to 1944, which was about the time that the eye-irritating effect became most evident. The peculiar meteorological and topographical situation in the Los Angeles area which causes the formation of smog is discussed in detail. The method, by which the Stanford Research Institute's numerical smog index was determined from solely meteorological data, is explained; it has proved to be a reliable indicator of the presence of eye irritation in Los Angeles. From a correlation of smog with upper air pressures and surface air movements, smog and smog-free days may be forecast. CHOH, SO_3, SO_3 and CHOH, mixtures of aldehydes, C black and CHOH, CHOH/sea H_2O, SO_2, SO_2 and CHOH, acrolein, acrolein and C black, acrolein and CHOH, H_2S_n, and elemental S were tested with only the following giving any positive results. Acrolein may play a supporting role in eye irritation but it is not a chief offender. Hydrogen persulfide, H_2S_n, is highly irritating at concentrations as low as 0.2 ppm, although it did not produce the same effect as smog, but rather nausea and headache. Elemental S, vaporized and suddenly cooled in an air blast, produced irritated eyes at approximately 2.6 ppm; suspended as finely divided S, definite eye and nose sensations of a dry, feverish nature occur at concentrations as low as 0.2 ppm. However, tests on eye irritating days have failed to show the presence of elemental S. It is concluded either that the material responsible for the irritating effect has escaped collection and identification, or that certain combinations or forms of materials exist that have powerful synergistic actions with materials already known. - KB

485. Marsh, A.: The December smog. A first survey. J. APCA 13:384-387 (Aug.) 1963; and, Smokeless Air, Spring, 1963.

The fog which developed on Monday, December 3, 1962, and did not clear until the following Friday, affected many parts of Britain, varying considerably in different places and at different times. The area most affected was the South-East of England, and as in 1952 the most dense and persistent fog was over London and the Thames Valley. The effects in certain other cities are noted separately, and the following report relates only to London.

The fog, which rapidly became smog, has been widely compared to the 1952 episode, which occurred between December 4 and 9. On that occasion the fog lasted rather longer and appears to have been, generally, somewhat denser and more persistent. In considering the effects upon health the fact that the fog duration was shorter in 1962 than in 1952 is less material than might appear, for in the earlier episode most of the deaths and illness occurred on the first and second days.

The depth of the fog, or height of the inversion, was similar on both occasions, namely, 300 to 400 feet, and as the photograph above shows, high points were at times above the fog and in bright sunshine. Temperatures in low-lying areas in 1962 were a little lower (about $1^{o}C$) than in 1952.

The full records and other data are not available at this time. - Author's Abst.

486. Martin, A.E.: Epidemiological studies of atmospheric pollution. A review of British methodology. Monthly Bull. Ministry Health (London) 20:42-49 (March) 1961.

Correlation techniques are seen to be the basis of most of the studies described, and since correlation tests indicate merely a mathematical association and not necessarily an association of cause and effect, the findings have to be interpreted with care. Many of the studies which do not use the actual correlation test are subject to the same criticism since they also indicate merely an association between 2 or more indices. Comparative studies of different areas are particularly difficult owing to variations in the social, environmental, occupational and, sometimes, racial background of the populations. In general, also, investigations of the medium and long-term effects are more liable to suffer from fallacies due to the existence of other influences than are studies of the immediate effects of air pollution. Much of the early work on atmospheric pollution was based on monthly data from deposit gauges and from lead peroxide cylinders for the estimation of SO_2. The deposit gauges measure grit and dust most of which is too coarse to travel far from the point of emission and is too coarse also to reach the human lung. The lead peroxide cylinders are found to be affected by wind, temperature, and other factors as well as by atmospheric SO_2. Most of the recent British work has therefore been based on estimates of black suspended matter (smoke) from either the daily smoke filter or the Owen's automatic filter and of SO_2 by the volumetric method. The daily values from these instruments while still far from perfect are more suitable for epidemiological investigation and their utility is clearly evident in the study of sudden changes in atmospheric pollution where daily readings make it possible to compare successive incidents in the same population and thus avoid the difficulties attendant on comparing populations in different areas. It is clear that from the chemical point of view both black suspended matter and SO_2 are somewhat crude indices but until more is known of the actual toxic substances in the air they provide a convenient and ready method of measuring the general air pollution. - KB

487. McCabe, L.C., and Clayton, G.D.: Air pollution by hydrogen sulfide in Poza Rica, Mexico. An evaluation of the incident of Nov. 24, 1950. AMA Arch. Indust. Hyg. Occupat. Med. 6:199-213 (Sept.) 1952.

Since the reactors for converting H_2S from natural gas to S were not yet complete at the new S-recovery plant at Poza Rica, Mexico, the H_2S rich gas absorbed in the Girbotol units (operation started Nov. 21, 1950) was sent to a flare, 90 ft. above the ground, at a rate of 10,000,000-11,000,000 $ft.^3$/day. S-free natural gas was added to assure a combustible mixture. When the scrubbers were first put into operation, difficulty was encountered and some of the absorption solution overflowed, partly plugging the gas lines to the pilot lights, and the flare was reduced in height. The absorption units were shut down, the lines drained and the flare relighted; it then burned normally. On Nov. 24, at approximately 2:00 a.m., efforts were made to increase the rate of flow of gas to the plant's rated capacity of 60,000,000 $ft.^3$/day. The desired rate of flow was reached at approximately 2:30 a.m. At approximately 4:00 a.m. difficulty was encountered, and the gas flow began surging through the unit, with the probable result that unburned H_2S escaped into the atmosphere.

Poza Rica lies on the Rio Cazones flood plain (el. 173 ft.) with hills surrounding the valley. At that time, low altitude temperature inversion, little wind movement and pronounced fog prevailed, and thus prevented the normal mixing and dispersion of the stack effluents. The wind direction was the major contributing factor affecting the flow of contaminants.

The houses consist mainly of 1 room and are built to allow maximum air movement. The people in the affected area (N of the plant) were aroused from their sleep in the early morning by an air pollutant which, from 4:50-5:10 a.m., when maximum concentration of H_2S was reached, resulted in the hospitalization of 320 persons, with death of 22 persons ranging in age from 2-50 years (9 were under 13 years of age, 10 between 14-35, 3 between 36-50). Of the total 320 treated at the hospital, 170 were discharged after 2-3 hrs., 90 after 6-7 hrs., 32 after several days; 17 died within 6 hrs. after arrival at the hospital and 5 after 1-9 days. Of the animal population, all the canaries in the area were reported killed and approximately 50% of all other animals died.

The exposure produced loss of the sense of smell, irritation of the respiratory system with a high frequency of cough, dyspnea and pulmonary edema, of the conjunctiva from direct contact with the contaminants, of the gastrointestinal tract with nausea and vomiting, of the nervous system with unconsciousness, severe headache and vertigo. The effects of the exposure on the respiratory and digestive systems did not last long, indicating rapid oxidation in the body of the toxic substance to the nontoxic product. The effect on the nervous system was more prolonged, and the degree of this effect was the determining factor in the fatalities. Selected pertinent clinical findings and the frequency of symptoms and signs on 47 hospitalized persons are tabulated. 9 case histories typical of the acute onset and sudden death, as well as the symptoms and signs are presented. 4 of the survivors exhibited nervous system sequelae, acoustic neuritis, dysarthria and aggravation of epilepsy attributable to damage to the nervous tissue from asphyxia and prolonged anoxemia.

A necropsy was performed on a 22-yr. old woman who had died suddenly. Gross and microscopic examination gave the diagnosis of pulmonary edema and congestion, cerebral congestion and patechial hemorrhage. Sections of a dog's lung showed marked congestion and edema; there was passive congestion and fatty degeneration in the liver. - KB

488. Mehrstens, J.H.: Solution of the problem of the smoke nuisance. Glasers Annalen für Gewerbe u. Bauwesen 60: 1907. (Abst. Mellon Inst. Smoke Invest. Bull. No. 9).

A general resume of the effects of various constituents of smoke upon health: "It is not the dust only that is injurious, but it is the invisible products of combustion escaping from the chimney in the form of gases, of which we need to take into consideration only carbonic acid, nitrogen, carbon dioxide, carbon monoxide, sulfur trioxide, sulfur dioxide and sulfurous acid and other heavy gases. Carbonic acid and nitrogen can probably be regarded as injurious only when they are driven directly into dwellings, and this cannot happen unless the chimneys are not high enough. The carbonic acid, which is extremely poisonous, is usually present in such light quantities that it becomes greatly diffused as soon as it escapes from the chimney. On account of its lightness, it also arises rapidly and is lost in the higher strata of air; but, on the other hand, the gaseous sulfuric acid (sulfur dioxide) which is considerably heavier than air, is such an injurious gas that first of all our efforts must be directed toward preventing it from doing harm, all the more as it is not only the human organism that is injured but also, in a positively destructive manner, the vegetation, soil, and buildings. Those facts show that any smokeless furnace with a direct combustion has little value for the public as far as the purification of the air is concerned unless the dust and the sulfurous acid are retained at the same time. - BAAP

489. Meyers, C.E., James, H.A., and Zippin, C.: The recovery of aerosolized bacteria from humans. I. Effects of varying exposure, sampling times, and subject variability. Arch. Environ. Health 2:384-390 (April) 1961.

Subjects were exposed to bacterial aerosols under several conditions of exposure and sampled at intervals of up to 2 hrs. after exposure. The effect of dose upon recovery varies with the conditions of exposures and sampling, but generally higher doses result in higher recovery. The duration of the exposure beyond a single inhalation does not appear to affect recovery. Receipt of the dose in a single inhalation results in better recovery at particular doses. Recovery from the extreme low doses and other cited experiments appears to indicate that deposition or retention occurs to a greater extent with bacterial particles than with inorganic particles of similar size. Subjects vary widely in recovery patterns, ranging from P-0 to P-88. The explanation for this is not at hand but may lie in anatomical or physiological differences, such as the properties and amounts of mucus, particularly of nasal mucus. James, H.A., Zippin, C., and Meyers, C.E.: II. Estimation of number of samples necessary for specified assurance of detecting exposure to an indicator organism. Ibid. 391-6. Conservative estimates of the probability of recovery after exposure to specified numbers of organisms under varying conditions of exposure and delay in sampling were calculated from the experience with 91 men. These estimates formed the basis for graphs which provide guides to the number of samplings required to detect exposures under specified conditions with specified degrees of confidence corresponding to a range of theoretical probabilities of recovery in a single sample. - APCA

490. Mills, C.A.: Air pollution and community health. Am. J. Med. Sci. 224:403-407, 1952.

Death rate studies, specific for age, sex and color, were made in Chicago's most polluted and cleanest contrasting areas. The death rates for pneumonia rose sharply in all categories with advancing age, were always higher for male than for analagous sections of female populations, and were always higher in the dirty areas than in the clean. In the cleanest areas, rates/100,000 ranged from 6 (ages 30-39) - 324 (ages ≧ 75) for males and 3 - 171 for females; in the dirtiest areas they ranged 38 - 497 for males and 10 - 267 for females. The ratios of the rates for the dirty and the clean areas were greatest for the youngest age-decade studied (30 - 39 years) and lessened steadily on toward the old-age extreme for both sexes (for males, from 6.27 at ages 30-39 down to 1.53 at ages ≧ 75; for females, from 3.33 at 30-39 to 1.56 at ≧ 75). This is attributed to the greater physical activity of men in the earlier decades and a consequent inhalation of greater volumes of the dirt-laden air. Highest rates for every decade were found among residents in the dirty Loop area and in the areas adjacent to it on the west. With respiratory tract cancer death rates, the most significant finding was that the astonishingly high old-age male rates came on a full decade earlier in the most polluted sections of the city (rate of 252 at ages 60-69) than in the clean (rate of 239 and 246 at ages 70-74, 75 and over). There seemed to be no significant difference between clean and dirty districts in the final old-age rate attained, "except possibly for a slight indication of exhaustion of the supply of cancer-susceptible individuals at the older ages in the dirty areas."

Regional differences of sootfall within the city of Chicago showed fairly close correspondence with SO_2 concentrations in the air: concentrations of SO_2 - 0.40 ppm in the Loop, 0.27 ppm in the congested South Side residential areas and 0.10 ppm in the cleaner outlying residential areas; concentrations of sootfall - 160 tons/sq.mi./winter mo. in the Loop, 70 in the South Side and 20 in the outlying areas. In the author's opinion, this gives added significance to the correlation studies in which sootfall data were taken as the best index available of prevailing air pollution. - KB

491. Mills, C.A.: Respiratory and cardiac deaths in Los Angeles smogs. Am. J. M. Sc. 233:379-386 (April) 1957.

Ozone or oxidant type smogs, now known to be formed by the action of sunlight upon stagnant inversion air masses containing unburned hydrocarbons and nitrogen oxides from liquid-fuel motor exhaust fumes, have been present in Los Angeles for more than a decade and are now appearing with increasing frequency in other American cities as the density of motor transport vehicles increases. Although ozone was formerly considered a harmless (and perhaps beneficial) atmospheric ingredient, it is now recognized that concentrations of it above 0.2 ppm. are potentially harmful to exposed plant and animal life. In maximal allowable limit for industrial in-plant workers has recently been reduced from 1.0 ppm. down to 0.1 ppm. (barely detectable by a keen sense of smell). The present report shows a clearly significant association between Los Angeles smogs and rise in day-by-day respiratory and cardiac deaths in the exposed population. There no longer exists a reasonable doubt that this smog-death relationship is real and of significant proportions. The community health hazard thus generated calls for prompt and energetic measures to lessen pollution of urban atmospheres with liquid-fuel motor exhaust gases, as well as establishing the best possible control over all other known polluting sources. - APCA

492. Ministry of Health: Mortality and Morbidity During the London fog of December 1952, Report by a Committee of Departmental Officers and Expert Advisers appointed by the Minister of Health. Reports on Public Health and Medical Subjects, No. 95, H.M. Stationery Office, 1954, 61 pp.

The main object of this investigation of the medical aspects of the Dec., 1952 London fog was to try to discover the factors responsible for the increased mortality from a statistical investigation of the Registrar General's figures on the fatalities.

The meteorological factors (i.e., anticyclone centered over Southern England, low temperatures and absence of wind, and therefore, temperature inversion) and the distribution of the fog as obtained from recordings at a number of observation points throughout Greater London for Dec. 5-9 are given in detail. Measurement of the atmospheric pollution was collated by the Fuel Research Station of the Department of Scientific and Industrial Research (see Wilkins, E.T.: J. Roy. Sanit. Inst. 74:1-15, 1954). The daily total suspended matter (smoke) and SO_2 concentrations for Dec. 2-10 at 12 Greater London sites are compared with the mean Dec., 1951 concentration of these 2 pollutants. Highest concentrations of the 2 (4.46 mg./m.^{3} smoke and 1.34 ppm SO_2) occurred at Lambeth County Hall on Dec. 7-8 as compared with normal concentrations of 0.12-0.44 mg./m.^{3} smoke and 0.07-0.23 ppm SO_2. Sharp increases in both occurred from the 4th to the 5th. Maps showing comparative SO_2 concentrations throughout the whole area during Dec. 1951 and during Dec. 5-9, 1952 are given.

Information on mortality and morbidity from the General Register Office Statistics estimates that the number of deaths attributable to the fog was between 3,500-4,000, but closer to 4,000. The number of deaths/wk. (Oct. 18-Mar. 28) shows a sudden rise in the wk. ended Dec. 13 followed by a marked fall to a level well above that for the wks. immediately preceding the fog. The number of deaths/day (Nov. 29 - Dec. 16) shows that the peak occurred on Dec. 7-8. Wilkins' opinion that the 2nd peak in mortality during Jan. and Feb. might be due to the after effects of the Dec. fog or to a 2nd rise in atmospheric pollution in Jan. and Feb. is discussed; however, all the evidence points to the epidemic of virus influenza in Jan. and Feb. as being the cause of the great mortality at that time. The deaths by area (London A.C., Outer Ring, 160 Great Towns) are tabulated; this shows the greatest increases in deaths in the wk. ended Dec. 13 over the preceding wks. were in the Administrative County of London (200% increase) and the part of Essex lying within Greater London (148%), and the least in the part of Kent within Greater London (79%). No close correspondence between the areas of greatest SO_2 pollution and those of greatest mortality contrast, in both the '48 and '52 fogs, temperatures remained either at or a few degrees above freezing. However, mortality, and in particular that from bronchitis, in 1952 was much greater than in 1948, or in any other previous fog. The mortality from the Meuse Valley and Donora, Pa. fog incidents is also reviewed, and the similarity in the pathology of the conditions produced is pointed out.

From all the evidence, there is nothing to suggest that the Dec., 1952 fog episode produced a new clinical or pathological syndrome. It seems that the contaminated fog exerted its evil effects by exacerbating illness and by precipitating death in those already affected by other conditions, viz., respiratory and cardiovascular, mainly of a chronic nature. There is also evidence that not all cases of chronic respiratory disease were affected to an extent calling for medical attention. The immunity of these cases was attributed to the fact that they remained indoors at rest and for the most part in bed. SO_2, SO_3 and CO are discussed as probable irritants because of the similarity in their effects; however, concentrations during the fog of the latter 2 are not known.

The effects of the fog on cattle at the Smithfield Cattle Show are discussed in Appendix A. Neither the sheep nor the pigs in the show were affected. More detailed tabulated statistics on the distribution of SO_2 in the fog and mortality data are given in the Appendixes B-G. - KB

493. Morando, A.: Experimental and clinical contributions to human pathology due to sulfuric acid fumes. Med. lavoro 47:557-561 (Oct.) 1956.

Normal human subjects, not accustomed to inhaling sulfuric acid fumes, were made to inhale for 5-15 minutes air polluted with sulfuric acid concentrations from 0.35 up to 5 mg. per cu. m. Even at concentrations that are not subjectively detected by the persons under test, the respiratory flow rapidly increases and continues high until some minutes after the end of the test; the increase is more evident at higher concentrations. The increase in respiratory flow involves a reduction of the percentage of the acid retained in the respiratory system, and can be considered as a defense mechanism. Fifty-seven workers in the sulfuric acid production department were also followed up for several years; there was no evidence of a particular increase in the occurrence of bronchial or lung diseases, nor of conjunctival or pharyngeal irritation. Numerous cases of gastritis and gastro-duodenitis, gastric ulcers, and digestive troubles were observed. Chronic exposures to relatively low concentrations of sulfuric acid as those to which the workers under examination were exposed, seem to produce gastro-intestinal tract lesions more easily than respiratory system lesions. - English Sum.

494. Morrow, P.E.: Some physical and physiological factors controlling the fate of inhaled substances. Office of Technical Services, USDC, Washington, D. C., pp. 113-136.

Dust deposition is the active process wherein dust is removed from the air while it is being respired. The term implies the extent to which dust is removed in terms of the same measure of dustiness as used to characterize the inspired air. Some fraction of the dust deposited is not in reality on the surface membrane of the respiratory tract but in suspension within the lung air. In the over-all course of dust deposition the amount of dust so involved is relatively small and short-lived and is particularly insignificant when deposition is measured as a steady state condition. Dust deposition in the respiratory tract can be thought of as a process occurring within a small compartment of air with the same physical forces in control that are involved in the dust deposition from the environmental air outside of the body. The forces of interest include gravitational, mertial, and Brownian motion. Physiological and other factors governing the deposition of dust in the respiratory tract are reviewed. Attempts to predict deposition as a function of physiologic measurements are discussed. - APCA

495. Motley, H.L., and Phelps, H.W.: Pulmonary function impairment produced by atmospheric pollution. Dis. of the Chest 45:154-162 (Feb.) 1964.

1. The Los Angeles smog was found to aggravate the severity of emphysema by increasing the residual air and impairing still further air distribution in the lungs. 2. The Tokyo-Yokohama asthma type probably should be referred to as an allergic bronchitis, and this condition probably exists in many parts of the world. The control of the military personnel in Japan by the armed forces is unique, and this method of studying the effects of air pollution is not available in most other areas. Airway obstruction was a consistent finding, often associated with increased residual air and hypoxia. The present outlook is less favorable than at first thought regarding

complete reversibility when the subjects stay too long in the Tokyo-Yokohama area after the condition has become manifest. 3. The use of treatment rooms with air filtered over activated carbon has been demonstrated to protect patients against air pollution in Los Angeles and in the Tokyo-Yokohama areas. 4. An allergic type of bronchitis was demonstrated in an industry from the introduction of two chemicals in the manufacturing process, and the clinical and physiologic findings in the sensitive patients were similar to the Tokyo-Yokohama asthma type. 5. Cigarette smoking (personal air pollution) irritates the bronchial epithelium and appears to be an important factor in rendering individuals more susceptible to allergic factors in air pollution. Cigarette smoking impairs the transfer of oxygen to the blood from the lungs in severe emphysema. 6. Air pollution has become a serious medical problem in many of the larger cities of the United States, and all possible measures should be taken to reduce the pollution from all sources and to prevent further increases. - Authors' Sum.

496. Nelson, N.: Some toxicologic aspects of atmospheric pollution. Am. J. Pub. Health 45:1289-1301 (Oct.) 1955.

The discussion is restricted to respiratory irritation and lung cancer as possible effects of air pollution. Some of the recent papers on respiratory irritation are reviewed and discussed, including reports of the Donora and London episodes, the work of Amdur and associates on sulfur dioxide and sulfuric acid, and that of Haagen-Smit on oxidation of hydrocarbons. Three points merit serious consideration: (1) the probability that an individual already under stress, or a very young or very old person, may suffer significantly from a level of an irritant innocuous to a healthy adult; (2) the physical state of pollutants, whether particulate or gaseous; and (3) the possibility that pulmonary irritants other than those conventionally accepted as important may be making a significant contribution. In general, nonspecific irritants acting separately or additively may be important as causes of respiratory disorder. All these points require further investigation. Some significant papers on air pollution as a possible cause of cancer are also reviewed and discussed. From information presently available it can be stated that: (1) there is probably a higher incidence of lung cancer in urban than in rural groups; (2) urban and industrial centers have higher concentrations of known carcinogens than areas with less air pollution; (3) no definite conclusion can be based on these possible related factors at this time. - APCA

497. Neumann, W.: Demands on clean air from the point of view of physicians and toxicologists. Staub 23:130-135 (March) 1963.

Air pollution abroad has repeatedly led to sudden increase in severe illness and fatalities. Relationships to certain chronic illnesses have become evident; in the case of bronchial cancer to cigarette smoking too. The maximum emission concentration (MIK values) for important gaseous pollutants named in the Directives of the VDI Commission on Maintenance of Clean Air are based on toxicological experiences and investigations. Their observance, seeming possible in normal weather by technical and constructional means, must be demanded. Moreover, modifications of the medical statistics and the creation of certain research institutes to explain essential special medical questions are necessary. - English Sum.

498. Patno, M.E.: Geographic study of cancer prevalence within an urban population. Pub. Health Rept. 69:705-715, 1954.

Pittsburgh, Pa. was divided into 16 homogeneous areas and data collected to study the differences in the distribution of cancer morbidity according to age, sex and race. The basis for the selection of the geographic areas, the population base used and the methods of analysis and results are discussed. Tables 1 and 2 show the population and the cancer prevalence/100,000 according to 5 age groups for the 16 areas for white males and white females in 1947.

Area 1, with the lowest socioeconomic status, the highest proportion of nonwhites, and the greatest number of foreign-born persons, had the highest cancer prevalence (43% higher than the rest) and mortality among white males of the whole area. Both white and nonwhite females experienced high prevalence and mortality. The non-white males' rate, however, was lower than that of the other areas. Prevalence of cancer of the skin and respiratory system was especially high among the white males, that of the buccal cavity, pharynx and "other" sites as relatively high, that of the genital and digestive organs average and that of the urinary organs lower than the rest. Cancer prevalence for nonwhites between area 1 and area 2, with a high socioeconomic status, had the second highest prevalence rates for white males and highest for white females. Highest rates were for breast cancer and then for cancer of the digestive organs. The 2 areas of lowest prevalence, areas 15 and 16, were both of low socioeconomic status, but with fewer nonwhite and foreign-born people than area 1. Area 8, predominantly an Italian section, experienced the lowest rates for white men for cancer of the digestive organs, both in prevalence and mortality. This has been noted before for Italian-born males.

Air pollution as a possible cause of the high rate of skin cancer and cancer of the respiratory system in area 1 is argued against because (1) the air pollutants in previous smogs spread over a wider area and became more concentrated in a part of area 16 and (2) these pollutants would certainly affect the white women and nonwhite men and women as well as the white men of the area. The relationship of socioeconomic factors to the number of cases of cancer diagnosed, and thus to the prevalence rates, is discussed, but no significant relationship could be established. - KB

499. Peart, A.F.W., and Josie, G.H.: Some considerations in planning a comprehensive study to determine the effects of air pollution on health. A review of methodology. Arch. Indust. Hyg. & Occupat. Med. 7:326-338, 1953.

An investigation of the Detroit River area was being carried out by the Technical Advisory Board on Air Pollution of the International Joint Commission in an attempt to study the effects of air pollution on health. The basic considerations of such a comprehensive study, which are discussed very generally, were applied practically by this investigation. Two general approaches were used: (1) a review of existing health data in the Detroit River area for comparison with other cities and (2) the conducting of a sample morbidity survey in the area to measure and compare the intensity and types of sicknesses and symptoms in well-defined areas of high and low pollution. A review of the existing health data included consideration of mortality statistics, hospital and medical care records, industrial and school records, communicable disease reports and others. For the sample morbidity survey, paired sample areas were selected and matched according to socioeconomic factors with 1 a high pollution area and the other a low pollution area. Two such pairs of matched areas (1 of white population and the other colored) were selected in Detroit and 1 pair (white population) was selected in Windsor. Control areas with the same socioeconomic factors but with no air pollution were selected in the same vicinity.

The amount of pollution in the various areas throughout Detroit and Windsor was determined by analyses of samples collected daily for 6 weeks in 28 census-tract areas in Detroit and at 25 stations in Windsor. The median, maximum and minimum concentrations (in $\mu g./m.^3$) of the metallic elements detected (Si, Ca, Al, Fe, Mg, Pb, Mn, Cu, Zn, Ti, Sn, Mo, Ba, Ni, V, Cr, Cd, Be, Sb, Co) are listed for Windsor and for Detroit; wide ranges between the maximum and minimum values are noted. SO_2 analyses were also run; median concentration in the U. S. area was 0.046 ppm, while that in the Canadian area was 0.023 ppm SO_2. It was planned that ca. 1,000 households, 500 in Detroit and 500 in Windsor, would be visited for the morbidity survey. The data would be based largely on a statement of illness by the informant (housewife generally), and the accuracy of the lay statements would be determined by a physician's diagnosis where possible. Refinements in methods would be added as the survey progressed. A careful assessment of initial health status at the start of the study was also made. Special groups, e.g., infants, asthmatics, persons with cardiac disease, etc., who were likely to be more sensitive to air pollutants would be more carefully studied. The records kept included (1) a household record card which contained general family and environmental data, (2) a record of present health status, including preexisting conditions, (3) an individual sickness record and (4) a supplementary sickness record. From this investigation, it was hoped that a reliable index of air pollution and an equally reliable health index might be discovered. - KB

500. Pemberton, J., and Goldberg, C.: Air pollution and bronchitis. British M. J. 2:567-573, 1954.

The crude death rate from bronchitis shows a steady and marked increase in passing from rural areas to towns, cities and conurbations in 1951: 69.4-132.1/1,000,000 for males and 47.3-73.7 for females. Since air pollution was thought to be a possible cause of this increase, the relationship of the bronchitis mortality rates for men and women aged 45-64 and 65+ with air pollution, as indicated by SO_2 content and total solid matter content of the air in the county boroughs of England and Wales, was statistically evaluated for '50, '51, and '52. However, the air pollution recording stations were not always placed to record average conditions, making the results somewhat dubious. Statistically significant correlation was found between the average SO_2 content and mortality rates in men in both age groups for all 3 years; such correlation occurred only in women aged 65+ in '51 and '52. There was no significant association between the average SO_2 pollution and the general social conditions, as measured by 2 indices - 1 based on income and 1 on housing conditions. A significant correlation between air pollution from solid matter and bronchitis mortality rates occurred only in men aged 45-64 in '51 and '52 and aged 65+ in '52 and in women aged 45-64 and 65+ in '52. It is concluded that SO_2 pollution may be a factor in determining the magnitude of the bronchitis death rates of middle-aged and elderly males. - KB

501. Pemberton, J.: Air pollution as a possible cause of bronchitis and lung cancer. J. Hyg. Epidemiol. Microbiol. Immunol. 5:189-194, 1961.

Daily measures of air pollution - amount of dark smoke (mg./m.^{3} of air) and amount of acid gas (mainly sulfur dioxide in pphm/24 hrs.) - have been made in the City of Sheffield at some 30 locations. The mean winter smoke pollution in Sheffield varied from a low of 9 mg./m.^{3} in an outlying area to 87 mg./m.^{3} in the center of the city, with the greater majority of the sampling points, which were located in an industrial area of dense housing, having a mean reading of over 60 mg./m^3. On two occasions when a sudden rise in pollution was recorded there also occurred a marked increase in the illness reported by a group of men suffering from chronic bronchitis and in the number of new attacks of bronchitis registered in the whole male working population. There was also an excess of deaths from bronchitis and from lung cancer in those areas of the city which were most polluted. This association, however, disappeared when allowance was made for the concomitant geographical distribution of such social factors as housing density, type of occupation, and social class. It is concluded that these observations and those of other workers strongly suggest that air pollution is one of the causes of exacerbations of deaths from bronchitis. It may also be one of the causes of lung cancer but the evidence for this is not conclusive. A similar study in Belfast, North Ireland, has progressed to about the mid-point; the findings would appear to be similar to those of Sheffield. - APCA

502. Perry, K.M.A.: Lung disease due to inhaled dust. Postgrad. M. J. (London) 35:470-475 (Aug.) 1959.

Dust particles must be of a size less than 5 µ to pass through the bronchioles and reach the alveoli of the lungs. Although many dusts are inert, others cause a fibrous and a pathological chest condition known as pneumoconiosis, and a few have been to be carcinogens and to contribute to the great increase in the incidence of carcinoma of the lung. In 1900 there were 273 deaths in England and Wales from this latter condition; in 1920 there were 500; and in 1955 this number had increased to 17272. It is possible that the part played by air pollution is greater than is at present realized. Among the inert dusts which cause x-ray shadowing of the lungs are iron oxide, with the condition known as siderosis; tin oxide, stannosis; and barium, baritosis. Certain dusts of organic origin cause inflammatory reactions in the lungs. In those persons who work around sugar cane residue, the respiratory condition known as bagassosis often results; in cotton workers, the condition of byssinosis may occur. Silicosis is a fibrosis of the lung caused by the inhalation of free crystalline silica or quartz particles. It is the most disabling of all the dust diseases. Pneumoconiosis of coal miners is the most important dust disease in the British Isles. The dust inhaled by coal miners is a mixture of coal, silicates, and silica. Of the silicate dusts, asbestos and talc produce severely disabling diseases and even death, whereas it takes many years for china clay and mica to produce any noticeable changes and then they are slight. Considerable evidence has been accumulated indicating that arsenic and the monochromates are carcinogenic. Also there is an incidence as high as 15% for carcinoma in asbestos workers, most of whom are women. - APCA

503. Pirila, V., Noro, L., and Laamanen, A.: Air pollution and allergy. Acta Allergol. (Copenhagen) 18:113-130, 1963.

Air pollution is becoming an increasingly important health problem in the industrial world. Up to now, too little attention has been paid to the relations between air pollution and allergy. After describing some examples of acute air pollution episodes, the authors give a brief review of natural air pollution from the allergological point of view. The capacity of some chemicals present in outdoor air--SO_2, H_2S, NH_3, Be, and F--to provoke allergic diseases is discussed on the basis of the literature and of personal investigations. Some figures are also given regarding the quality and degree of air pollution in the U.S.A. and in Finland. For the U.S.A. these are given as 5-62 tons/miles^2/month, with a high of 291 tons/miles^2/month in Pittsburgh. In Helsinki, Finland, in 1959 these amounts were in the range of 5.6-30.5 tons/miles^2/month. The dustfall in the typical countryplace of Tuisniemi (31 inhabitants/miles^2) varied in 1961 from 0.1 to 1.8 tons/miles^2/month. The authors stress the difficulty which arises in fixing the max. allowable concentrations for general air pollution, owing to the wide variations in physiological response in general and in allergic reactivity in particular. - APCA

504. Poliak, V.E.: Hygienic justification for a sanitary protective zone around a chemical plant. Gig. i Sanit. 27:75-78 (Feb.) 1962.

Samples of the air around a chemical plant producing H_2SO_4, HCl, Na_2S, agricultural-control chemicals, and fertilizer, were collected and analyzed. It was discovered that atmospheric pollution was present not only in an area close to the plant but also at a considerable distance. The content of H_2SO_4 in the air was found to be at levels beyond the limits considered to be safe for humans. The max. concentration was discovered at a distance of 500-750 m. from the plant; up to 1250 m. the concentration was still twice that considered to be safe. The level of nitrogen oxide at 1000 m. reached 15.56 mg./m.^{3}, an amount many times the level considered to be safe. Dust levels at 500 m. ranged from 5.8 to 7.97 mg./m.^{3}. Studies of persons living in the vicinity of the plant, and other investigations, resulted in a recommendation that the sanitary zone around the plant be extended to 1000 m. - APCA

505. Prindle, R.A. and Landau, E.: Health effects from repeated exposures to low concentrations of air pollutants. Pub. Health Rep. 77:901-909 (Oct.) 1962.

The great volume and variety of air pollutants in the United States offers unparalleled opportunities to study the chronic effects of low-level air pollution on health. In what other country is there amassed the concentration of automobiles found in Los Angeles with its resultant oxidant type of smog? The lethal concentration of pollutants in Donora in 1948 created a far different air pollution problem than is found currently on the west coast. In the United States, air pollution arises from many and varied sources in every category, industrial, residential, municipal, and automotive, and makes necessary a wider range of research activities than in many other countries.
In summary, we in the United States are devoting considerable time and effort to this important question: Does long-time exposure to low concentrations of air pollution result in adverse health effects? Our preliminary answer, based on both laboratory and epidemiologic studies, is yes. The evidence as yet is only qualitative; much more will have to be done before the necessary quantitative answers are found on which to base rational control standards. Hopefully, with the data the Public Health Service is able to collect and that amassed by researchers in Europe and throughout the world, this goal can be attained. - Authors' Abst.

506. Prindle, R.A., and Landau, E.: Damage to health following repeated effects of low concentration of air contamination. Staub 22:392-398 (Oct.) 1962.

For diagnosing chronic effects caused by substances polluting the atmosphere, clinical tests on man and animals were performed. Statistics on injuries by atmospheric pollution in industrial centers have been analyzed. Special attention has been given to those substances particularly annoying in the U.S. such as SO_2NO_2, photochemical smog, oxidants, and CO. The effects of the individual substances as well as the effects of them in combination were tested. A report of the results is given. - APCA

507. Prindle, R.A., Wright, G.W., McCaldin, R.O., Marcus, S.C., Lloyd, T.C. and Bye, W.E.: Comparison of pulmonary function and other parameters in two communities with widely different air pollution levels. Am. J. Pub. Health 53:200-218 (Feb.) 1963.

(1) A study was conducted among persons 30 years of age and older in two small neighboring communities characterized by marked differences in levels of air pollution. These individuals were offered a series of pulmonary function tests, a 14 x 17 chest x-ray, and a comprehensive questionnaire which included not only information on respiratory illness, but also details of residence history, smoking habits, and occupation.

(2) Air sampling was done from October, 1959, through April, 1960. Seward pollution values were higher compared to New Florence. The average sulfur dioxide values were 6.2 times greater, dustfall was 3.2 times greater, and soiling was 1.5 times greater in Seward. A vegetation survey in June, 1960, disclosed sulfur dioxide injury to plants in Seward and vicinity with no similar damage at New Florence.

On the basis of past records, it would appear that these sulfur dioxide values are representative of those in the past. However, particulate pollutant levels have been decreasing since control devices were installed.

(3) While differences in smoking habits, occupational exposure, and length of residence may well be important, these factors have not been thus far analyzed in detail.

(4) An interim finding was that statistically significant differences in Average Airway Resistance and Airway Resistance x Volume were found between the two communities for each sex, even after differences in height and age were taken into account. If they persist after additional variables have been analyzed, these differences may reflect the difference in air pollution levels.

(5) The remaining pulmonary function measurements did not show any statistically significant differences between communities after age and height for each sex were taken into account.

(6) The x-ray interpretations reveal a higher proportion of males with pneumoconiosis in Seward; this may be partly due to the larger proportion of coal miners in Seward. On the other hand, New Florence shows a larger percentage of males with emphysema.

(7) Films for males were interpreted as "normal" in equal percentages for both communities--approximately one out of three. In the case of females, six out of ten examined in Seward were graded as "normal" against five out of ten in New Florence.

(8) The technics employed in this study may prove helpful in further defining the public health problem of pneumoconiosis, emphysema, and bronchitis in relation to air pollution. - Authors' Sum.

508. Prindle, R.A.: Notes made during the London smog in December 1962. Arch. Environ. Health 7:493-496 (Oct.) 1963.

Author relates impressions and experiences of his visit to London during the smog episode of December 1962. On the evening of his arrival Dec. 6, he noticed "...a continuous metallic taste in the mouth and irritation of the nose, pharynx, and eyes...visibility outside the hotel was about 15 feet..."

Author visited several hospital wards and interviewed some of the patients with chronic bronchitis who were affected by this smog episode. All of the patients interviewed had had long-standing chronic bronchitis. Several indicated that they suffered prior episodes associated with the 1952 and 1957 smogs. One hundred and thirty-three excess deaths were estimated in the city of London. Data gathered indicated that the smoke levels of the present episode were about one-third of those in 1952, but that the SO_2 was about the same. It seems quite likely that the smog episode was nowhere as severe as 1952, and the changing situation in London, including the smokeless zones, new builidngs and better utilization of fuel, have all contributed, along with certain meteorological events, for the betterment. Author mentions the stack gas sulfur dioxide removal project and a study of diesel emissions of the Warren Spring Laboratory at Stevenage.

509. Rawlins, A.G.: Use of sulfur dioxide in the treatment of the epidemic cold. Arch. Otolaryng. 25:119 (Feb.) 1937.

The study is limited to epidemic colds which pass through families and neighborhoods, as does measles, in contrast to flare-ups of sinusitis or streptococcus sore throat. The use of sulfur dioxide was prompted by success in destroying plant viruses with 0.6 to 1.5 percent sulfur dioxide.

Sulfur dioxide was administered by inhalation of sulfurous acid gas. Of 80 patients, 14 received no relief, and 66 stated they were completely cured on the 1st or 2nd day after therapy was started. These 66 patients stated that their colds usually lasted 1 to 2 weeks. Treatment in each case was given in the prodromal stage of the cold. The same therapy was tried after 3 or 4 days of onset with practically negative results. "It was found that in what was apparently an epidemic of colds, sulfur dioxide gas inhaled in the first 12 hours stopped the cold in 24 hours in a large percentage of the cases." The technic required getting the sulfur dioxide gas into the upper respiratory tract without getting appreciable amounts into the lungs. The possibility of decreased colds among workers exposed to sulfur dioxide is discussed. The author questioned a few workers and one plant manager in a plant where there was exposure to sulfur dioxide and found that colds were infrequent. - BAAP

510. Ritchie, A.W., and Langrishe, J.: Smoke abatement. J. Soc. Chem. Indust. 54:979-982, 1935.

Mr. Allen, Chief Sanitary Inspector, Edinburgh, discussed the causes of smoke, the measures taken for the reduction of smoke and the investigation into atmospheric pollution. The data from the deposit gauges at 3 places in the city are given for 1929-34. The values ranged from 13.67-16.67 at Leith Links, 12.80-15.09 at Bruntsfield House and 19.78-27.51 tons/sq. mi./mo. at Princes St. Gardens. The Owens automatic air filter showed that pollution is at a minimum at 3 a.m., increases to a maximum at 9-10 a.m., decreases again till 3 p.m. and then reaches a secondary maximum at 7 p.m. Pollution is about 31% less in summer than in winter. A comparison of the results obtained on weekdays and Sundays indicate that 4/5 of the pollution in the City is domestic and 1/5 industry. December has the highest pollution and July the lowest. Measurements of S pollution by bubbling the air through H_2O_2 solution and subsequent titration showed <0.1 ppm SO_2 in Nov. and Dec.

Lt. Col. Langrishe reported that from the statistical evidence the number of deaths from pulmonary and heart diseases increased in direct proportion to the intensity and duration of smoke-fogs. As cited by Baillie Brownhill Smith, in Nov. and Dec. 1909, Glasgow had 3 periods of dense smoke-fog. Deaths from respiratory diseases during the week preceding the fog totalled 75; during the week of the 1st fog period they amounted to 138 and in the ensuing week they rose to 233. Over the whole period of bad fogs the respiratory death rate rose from 2.1-13.9/1000, while in 7 other towns, fog-free at this time, the rates rose from 1.6-4.8/1000. This difference in Glasgow had accounted for 1000 actual deaths. The effects of obstruction of sunlight are distinct. Manchester on a still day receives 55% of the daylight received in Timperley, only 6 miles S, and on foggy days it receives but 5%. Even less UV light with its less penetrating powers is received. The loss of visibility is also hazardous. A 25% increase in industrial accidents is estimated to be caused by reduction of visibility indoors, and the compensatory use of artificial lighting is estimated to cut output by 11%. The stunting effect of loss of solar radiation on human beings, the psychological ill effects and the action of smoke on vegetation are mentioned. - KB

511. Roberts, A.: Air pollution and bronchitis. Am. Rev. Resp. Dis. 80 (Part I):582-584 (Oct.) 1959.

Although the term chronic bronchitis has been considered rather obsolete in diagnosis in this country, it is one in common use in Great Britain. There the term does not apply to benign and inconsequential bronchial trouble but to a progressive respiratory disorder in which the factor of bronchial disturbance is a constant denominator. As the bronchitic process advances, the lung parenchyma is involved and emphysema gradually develops. Cor pulmonale is often an associated complication. The importance of the chronic bronchitis syndrome in England and Wales lies in its socioeconomic aspects. In a total population of some 45 million, chronic bronchitis outranks all other respiratory diseases as a crippler and killer. It accounts for the loss of nearly 27 million working-man hours and is given as the cause of death in 30,000 certificates every year. The factors involved in the etiology of chronic bronchitis have been subjected to intensive scrutiny for many years and recently an apparent relationship of the disease to atmospheric pollution has been indicated by several studies. The author concludes that the incidence of chronic bronchitis is grossly underestimated in this country and perhaps over-diagnosed in Great Britain to some extent. When data now being obtained by improved survey methods in both countries become available, we may be able to establish a valid estimate on the importance of chronic bronchitis among us. With this knowledge, we can then seek to clarify the relationship of the disease to air pollution in our cities. - APCA

512. Rokaw, S.N. and Massey, F.: Air pollution and chronic respiratory disease. Am. Rev. Resp. Dis. 86:703-704 (Nov.) 1962.

This report summarizes 18 months of a longitudinal study of the effects of environmental variables on pulmonary function in a relatively stable group of severely involved, chronic respiratory patients. Concurrently, a partial study of pulmonary responses to environment was made in subjects with no known respiratory impairments, selected from personnel of the Rancho Los Amigos Hospital, a chronic disease center for the County of Los Angeles. Constant monitoring of the environment was achieved at a field station of the Los Angeles Air Pollution Control District established on the grounds of the hospital. Variables measured included temperature, humidity, oxides of nitrogen (NO and NO_2), carbon monoxide, ozone, total oxidants, and oxidant precursors by the neutral potassium iodide method, and particulate matter by an automatic sampling device. Measurements of visibility, of sulfur dioxide, hydrocarbons, and other possible pollutants have not been achieved. The data have been validated and transmitted for biostatistical analysis. At this point in the data analysis some conclusions can be drawn. Some of these are mentioned here, such as the marked variability in performance of the pulmonary function tests especially for the patient group. In searching for associations of environmental variations with performance variations, only occasionally has a correlation number been found high enough to be "interesting." In only a few instances (6 of the 31 patients), was there a correlation number that seemed to indicate some major association. In 4 of these the exposure to carbon monoxide seemed to be involved. It cannot be stated that this pattern applied to all the patients. Certainly, they do not seem to have behaved uniformly as a group or, in other words, they do not all respond in a similar pattern on a day or during a period of heavy air pollution. Examining time series plots of the results of the various tests, the patients' performances on a given test over a year and a half do not indicate either a cyclic uniform performance for the group or any response to major smog episodes. - APCA

513. Romanoff, A.J.: Sulfur dioxide poisoning as a cause of asthma. J. Allergy 10:166 (May) 1939.

"Cook believed, on clinical grounds, that there may be a certain specificity in the inhalation of sulfur dioxide fumes, principally because this gas initiates attacks in relatively few asthmatic individuals, and in those who were free from asthma attacks for some time. However, there is no immunological proof of the specificity of sulfur dioxide fumes in initiating attacks of bronchial asthma." Those exposed to sulfur dioxide fumes have an inflammatory, destructive lesion in the upper respiratory tract. The mucous membranes are rendered helpless, and the bacteria gain the upper hand.

The inhalation of sulfur dioxide is very irritating to the upper respiratory tract. Sulfur dioxide plus moisture of membranes forms sulfurous acid, which is very irritating and in severe cases can produce bronchopneumonia and pulmonary edema. A group of 100 people with chronic exposure to sulfur dioxide had a diminution of taste and smell, and increase in the incidence of pharyngitis and tonsillitis, and an increase in fatigability and dyspnea on exertion. Three cases of asthma in refrigerator repair men are cited in which sulfur dioxide is said to be the cause of the asthma. - BAAP

514. Ruskin, S.L.: Pollution of the city air as a source of nose and throat disturbance. Science 84:84-85, 1936.

City planning for the control of air pollution is as vital as the control of milk contamination. The poisonous gases issuing from smoke stacks of industrial plants and incinerators are HCl, Cl_2, HF, oxides of N, NH_3, H_2S, CS_2, CO, $HCHO$ and HCN. Oxygen is the most important constituent of air; its source is plant life processes. Air pollution, however, damages vegetation, besides dirtying city streets. Both chemical pollution and smoke dust are harmful. The danger of air pollution is less in summer with more favorable meteorological conditions than in winter. These pollutants cause irritation of the nasal membrane with nasal obstruction and diminished ventilation of the nasal sinuses and thus create conditions favorable to bacterial infection with the ensuing susceptibility to colds and sinus infections. Removal to cleaner air will clear up the symptoms. Ways by which the city can control pollution are suggested. - KB

515. Salem, H., and Cullumbine, H.: Inhalation toxicities of some aldehydes. Arch. Environ. Health 2:641-647 (June) 1961.

Various animal species are affected differently by various atmospheric contaminants. Kerosene smoke, when administered prior to the exposures to each of the various contaminants caused no significant difference in their toxicity. When kerosene smoke was added simultaneously with those atmospheric contaminants, their toxic effects were modified. As has been described, in some cases the toxicity was enhanced, in others it was unchanged, or even decreased. - Authors' Abst.

516. Schaefer, T.W.: The contamination of the air of our cities with sulfur dioxide, the cause of respiratory disease. Boston Med. Surg. J. 157:106 (July) 1907.

The author had, for the ten previous years to 1907, studied the noxious effect of sulfur dioxide, and he concluded that it is one of the most patent causes of asthma. It is estimated that for every ton of coal burned, 3 tons of sulfur dioxide are formed. Sulfurous acid is formed from sulfur dioxide, and this is very detrimental to buildings and vegetation. "It is a well-recognized fact that, during periods of heavy fogs in manufacturing centers, the morbidity and mortality from respiratory diseases are increased very greatly, and that, as the atmosphere clears, a sharp decline follows." Sulfur dioxide is a local irritant producing coughing, bronchitis and pneumonia. Kiohna discovered, in his experiments with sulfur dioxide in rabbits, that the pulmonary capillaries were seriously damaged and the blood itself underwent chemical change. He believes that sulfur dioxide is a protoplasmic poison. He observed that long-continued, small doses affected the lungs seriously. Sulfur dioxide inhaled by some people will produce or bring on attacks of asthma.

"The various diseases of the air passages, including pharyngitis, bronchitis, pneumonia, and asthma, are materially influenced by meteorological conditions."

Legislation and prevention of the pollution of the air are suggested by the author. - BAAP

517. Schrenk, H.H., Heimann, H., Clayton, G.D., Gafafer, W.M. and Wexler, H.: Air Pollution in Donora, Pennsylvania. Pub. Health Bull. No. 306, 1949.

In the latter part of October 1948, Donora, Pennsylvania, a town of about 13,000 population, containing a zinc plant and a steel and wire plant, experienced a large number of acute illnesses and 20 deaths during a heavy smog. This report is based upon a carefully made epidemiological study, approached from the biological, the engineering, and meteorological point of view.

The data collection began after the episode was over and included: (1) Studies of acute morbidity by house-to-house canvass, records of fatal and hospitalized patients, and, finally, study of general morbidity; (2) Study of chronic morbidity by dental examinations of school children, by certain chest roentgenograms, and morbidity of selected groups of individuals; (3) Study of mortality records of the community and comparing them with similar records of neighboring towns; (4) Atmospheric studies of air pollutants; (5) Evaluation of industrial plant effluents; (6) Evaluation of air contaminants from other sources; (7) Description of the topography of the valley in which the town is located; (8) Micrometeorological studies of the valley; (9) Description of the weather during the acute episode in October, 1948.

Detailed descriptions of the methods used are presented since it was believed they would be useful to others making similar studies.

The study showed that the cause of the episode was an accumulation in the atmosphere of chemical irritants, this accumulation resulting from the weather inversion which existed in this part of the country during the fateful days. The parts played by all sources of chemical air contamination are discussed. A section is devoted to discussing the specific agent or agents probably responsible for the illnesses, and it is deduced that no one agent can be indicated. It was likely that it was due to a chemical irritant (possibly sulfur dioxide) plus particulate matter, although, because of the lack of knowledge about the toxic effects of low concentrations of the irritant gases, this cannot be said with certainty. - BAAP

518. Scott, J.A.: Fogs and deaths in London, December 1952. Pub. Health Rep. 68:474-479, 1953.

In this review of the London Fog of Dec. 1952, the daily concentration of smoke and SO_2 at London County Hall from Nov. 16-Dec. 27, 1952 are tabulated and graphed. Both show peak concentrations on Dec. 7 and 8 of 4.46 mg/m^3 smoke and 1.339 ppm SO_2, as compared with the summer (June) average concentrations of 0.12 mg/m^3 smoke and 0.07 ppm SO_2. The mean daily temperature was also recorded; a striking drop from the 80-year average is noted for the period, Dec. 5-8. The number of registered deaths in London increased sharply from 945 for the week ending Dec. 6 to 2,484 for the week ending Dec. 13; the number remained high (1,029-1,523) for the following 4 weeks ending Jan. 10, 1953. The increase in death rates was greater than that for the fog of 1873 or for the cholera epidemic of 1866. The deaths in the 6 weeks ending Dec. 27, 1952 are classified by age and the latter 3 weeks are compared with the average of the 1st 3 weeks. A 3-fold increase in deaths is shown for the 4th week (Dec. 7-13) for babies 4-52 weeks and for adults >55 and approximately a 2-fold increase for all other ages. The deaths are also classified by cause for each week in a similar manner as for age. Causes of death were almost entirely disorders of the circulatory and respiratory systems. Deaths from bronchitis for the week ending Dec. 13 were 10 times as many as those for the previous 3 weeks; from pulmonary t.b., 4½ times as many; from other respiratory diseases, 6 times as many; from lung cancer, 2 times as many and from disorders of the heart and circulatory system, 3 times as many. In the fog of 1873, greater mortality from respiratory and circulatory disorders and among the very young and old also occurred. Similarly, animals in the Smithfield cattle show became ill and some died during both fogs. - KB

519. Scott, J.A.: Fog and atmospheric pollution in London, winter 1958-59. M. Officer (London) 102:191-193 (Oct. 16) 1959.

The winter of 1958-59 was noteworthy for having a report of fog, as made by Kew Observatory, on 75 of the 182 days in the period of Oct. 1958 to Mar. 1959, with 18 of these days being in the month of Nov. On 3 occasions, of 2 to 3 days each, during this period atmospheric pollution, as a combination of "smoke" and "sulfur dioxide," neared what has been found in practice in London to be a critical level in relation to mortality. Table I in the text shows the trend of atmospheric pollution in London, especially over the 5 winters from 1954-55 through 1958-59. These figures indicate that the amount of "sulfur dioxide" has remained relatively constant but there has been a downward trend in the amount of "smoke." In 1954-55 these figures were 49 mg. "smoke" (suspended black material)/100 m^3 of air to 11.1 parts of "sulfur dioxide" (acidic gases)/100 million parts of air, with a ratio of smoke to SO_2 of 4:41. In 1958-59 these figures were 43 and 11.9, with a ratio of 3:61. This reduction in smoke is probably a mirroring of the reduction in the consumption of coal. Although it would undoubtedly be well to have the SO_2 reduced also, previous work would indicate that in relation to mortality smoke appears to be more injurious to health. The persistent fog in Nov. 1958, unaccompanied by high pollution, had little effect on mortality. Also the near-smogs of Jan. and Feb. 1959 appeared to have little or no effect on mortality. These facts support the hypothesis that the level of pollution in London begins to exert a critical effect upon mortality when the daily concentration reaches 200 mg. black suspended matter/100 m^3 of air if it is combined with 40 parts of acidic gases/100 million parts of air, even though evidence so far does not preclude smoke being the determining factor rather than the combination of the 2 pollutants. - APCA

520. Scott, J.A.: The London fog of December 1962. M. Officer (London) 109:250-252 (April 26) 1963.

In previous papers (Scott, 1956, 1958, 1959) it has been shown that, so far as London is concerned, a critical level of atmospheric pollution in relation to its effect on health was reached when the average daily concentrations of smoke and sulfur dioxide in the atmosphere were in the region of 200 milligrams of black suspended matter per 100 cubic meters of air and 40 parts of sulfur dioxide per 100 million parts of air, i.e., about four times the average level of the winters 1954-55 and 1955-56. In terms of the now more commonly used unit of micrograms per cubic meter this critical level is 2,000 for smoke and 1,140 for sulfur dioxide. - Author's Introduct.

521. Shilen, J., Mellor, J.F., Jr., Stang, A.M., Sharrah, J.S., and Robson, C.D.: The Donora smog disaster. Pa. Dept. of Health, Bureau of Indust. Hyg., Oct. 1949?.

This report is based partly on air tests made towards the end of the episode in Donora, Pennsylvania. It is suggested that sulfur dioxide, found in appreciable amounts, was the cause of the illnesses. Morbidity and mortality studies were also reported. These indicated, through dental examinations, that fluorides were probably not the cause of the illnesses; and, through chest X-rays, that chronic pneumonitis did not occur in the community. The mortality studies showed that death rates from cardiorespiratory diseases were not unusually high in Donora. - BAAP

522. Sinclair, J.D.: Etiology of asthma - physical and atmospheric factors. Bull. Postgrad. Comm. Med. Univ., Sydney 18:54-57 (May) 1962.

This paper was given at the Symposium on Asthma held in Sydney in Mar. 1962. Experimental work shows clearly that inhalation of sulfur dioxide, inert particles, and pollen extracts may cause an acute increase in airway resistance which is reversible with isoprenaline treatment. The clinical implications of these observations and of observations on the effect of atmospheric pressure, temperature, and wind velocity are not so clear. Every clinical paper quoted fails to define the disease of the patients discussed. This symposium had earlier defined asthma as a state of reversible airways obstruction. It is seldom clear whether the patients are young or old, and it is never stated whether their disease is continuous or paroxysmal. The Nashville Air Poll. Study does not, therefore, contribute all it should to the understanding of paroxysmal asthma. There is no reliable evidence of the effect of changes, particularly of sudden changes of temperature, pressure, or humidity on the frequency of asthma attacks in individuals. Seasonal and regional variations can be explained on the basis of atmospheric pollution, whether with allergens of nonspecific irritants. In future surveys, the effects of temperature inversion and of atmospheric ionization should be kept in mind. - APCA

523. Spicer, W.S., Jr., Storey, P.B., Morgan, W.K.C., Kerr, H.D. and Standiford, N.E.: Variation in respiratory function in selected patients and its relation to air pollution. Am. Rev. Resp. Dis. 86:705-712 (Nov.) 1962.

It has been presumed that chronic and/or recurrent infections and/or environmental factors influence the course of diseases characterized by chronic respiratory insufficiency. This insufficiency is characterized physiologically by obstructive airways and is called by such names as chronic bronchitis, adult asthma, and/or emphysema. To attempt to evaluate the role of environmental factors the authors have chosen to apply a number of measurement techniques to the daily course of a group of patients (all long-time residents of a 40 x 20 block area of Baltimore) with this type of chronic respiratory insufficiency. A large group was studied through a 5-day week in Nov.-Dec. 1960. The physiological results of the study are being compared with dirt sampling and weather information. Most importantly it was found that the patients, of a very heterogenous background, became physiologically better or worse together. And that when this worsening was related to the high or low levels of particulate matter collected, it was found that 50 to 67 patients at risk became worse during "peaks" while during "valleys" only 13 of 67 patients at risk became worse. In a second study, 14 of the same patients were evaluated each day for 47 consecutive days, and the air samplings were increased to include two-hour samplings of SO_2, NO_2, and dirt as well as to allow location and height variations. No tests were made for ozone. When all the pollutants were analyzed and an attempt made to correlate with the deterioration in respiratory function, it was not possible to find any one pollutant responsible, based on the limited statistical studies made to date. - APCA

524. Stocks, P.: Cancer and bronchitis mortality in relation to atmospheric deposit and smoke. British M. J. No. 5114:74-79 (Jan. 10) 1959.

When standardized mortality ratios for bronchitis and cancer in the county boroughs of England and Wales are related to the average amounts of undissolved deposit and smoke from the air in those towns, highly significant statistical correlations are found for bronchitis and lung cancer with both types of pollution after eliminating the effects of population density on the correlations. On the basis of pollution data from all the administrative areas in Lancashire and the West Riding of Yorkshire, bronchitis is significantly correlated with deposit but not with smoke, while for lung cancer the reverse is the case. In Lancashire areas, lung cancer is strongly correlated with population density in adjacent districts, even when that of the area itself is held constant; this appears to confirm the effect of wind-borne smoke on the incidence of the disease. Stomach-cancer mortality also is related significantly with both deposit and smoke in the county boroughs and among females in the Lancashire and Yorkshire districts. The most likely explanation of this is the exposure of food to dirty air. This hypothesis is supported by the fact that in the U.S.A. where wrapping of food was the rule long before it began to be practiced in Britain, death rates from stomach cancer have fallen steadily in contrast to this country. Negative correlations were obtained for breast cancer. Intestinal cancer also showed small correlations with deposit and smoke in the county boroughs, but they are below the conventional level of significance. - APCA

525. Studies of urban air pollution. Medical research council review. Smokeless Air, pp. 20-21, autumn 1962.

A review of the effects of air pollution upon human health is included in the Report of the Medical Research Council for 1960-61. (H.M. Stationary Office) The first part of this describes the nature and distribution of air pollution and after discussing the smoke and sulfur dioxide, reference is made to the oxides of nitrogen. On carbon monoxide it is said that "in calm weather the concentrations in busy streets frequently exceed those usually considered the maximum permissible exposure for eight hours in industry."

Reference is made to the tar present in coal smoke, and to new techniques for determining the quantities. The effects of smog episodes on mortality and morbidity are discussed.

526. Thomson, W.B.: Etiology of bronchitis. M. World (London) 92:217-220 (March) 1960.

Chronic bronchitis, which has a very important influence on the national economy of England, is now regarded as a serious disease, as is evidenced by several recent monographs on the subject. Some aspects of recent studies discussed are: a definition of the disease; the etiology, including the roles of smoking and atmospheric pollution; the role of infection; and the pathology. The author proposes a working definition, for the present, as follows: "A disease characterized by a productive cough on most days for at least three months every year for a minimum of two consecutive years, providing other pulmonary diseases have been excluded." Studies have shown an increasing incidence of bronchitis morbidity and mortality in industrial urban areas when compared with rural areas. A study in 1958 on a fairly homogeneous group of postoffice workers indicated wide geographic variations in the incidence of bronchitis. It was also stated that the variations in incidence could not be explained by any consistent difference in the climate other than fog, suggesting that chronic atmospheric pollution is relatively unimportant except insofar as it predisposes to polluted fog. Whether acute atmospheric pollution actually causes bronchitis remains undecided mainly because the effect on previously healthy young subjects is not clear. - APCA

527. Toigo, A., Imarisio, J.J., Murmall, H., and Lepper, M.N.: Clearance of large carbon particles from the human tracheobronchial tree. Am Rev. Resp. Dis. 87:487-492 (April) 1963.

A technique is described whereby carbon particles of known large size are labeled with a radioisotope (I^{131}) and delivered to the tracheobronchial tree of unanesthetized humans. The disappearance of labeled radioactivity from a field over the trachea and main stem bronchi was measured. It was demonstrated in preliminary observations that the clearance of carbon particles is faster in normal subjects than in subjects with chronic lung disease. The influence of cough upon clearance in both normal subjects and patients with chronic lung disease was observed. - Authors' Sum.

528. Toyama, T.: Epidemiologic study on effects of atmospheric pollution in urban areas. Rept. No. 1, 114-115. The Waksman Foundation of Japan, Inc., Tokyo, Japan. 1962. 123 pp.

This is 1 of the series of abstrs. of reports of investigations in microbiology and medical sciences supported by the Waksman Foundation of Japan, Inc. Wright peak air flow rate, 0.5 sec. expiratory capacity, and total vital capacity of 245 students of 10-11 yrs. of age attending the H-School in a heavily polluted area of Kawasaki City were measured monthly over the period of Feb. 1959 to July 1960. Air pollution indices, monthly determinations of dustfall by British deposit gauge, and sulfur dioxide concentration by lead peroxide candle method were made during the same period. The physiological data were compared with that of the control 163 students of 10-11 yrs. of age attending K-School in a clean air area in the same city. Dustfall, which was emitted largely from iron mills and combustion power plants, reached about 80 tons/$km.^2$/month during the spring and early summer. Average monthly Wright peak flow rate and 0.5 sec. expiratory capacity of the H-School children fluctuated in accordance with monthly dustfall levels with a striking parallelism. Behavior of total vital capacity showed no significance. Wright peak flow rate in the clean area always showed higher than that in H-School, and differences of average peak flow rate between the 2 schools in various months were correlated to the dustfall amount; the greater the differences of the peak flow rate of the 2 schools, the higher the concentrations of monthly dustfall at the H-School area. Questionnaire surveys showed more complaints of daily nuisances by the H-School children than by those of the K-School. - APCA

529. Van Leeuwen, W.S.: Sulfur dioxide or hydrofluoric acid poisoning? The fog catastrophe in the industrial region of Luttich. Chem. Zentr. 1:807, 1933.

"The cases of poisoning in the Meuse Valley in December 1930 were due to the formation of a fog loaded with the waste gases of numerous factories, chiefly sulfur dioxide and hydrofluoric acid. According to Fenner the poisoning effect was caused by the fluorine silicate or fluorsilicic acid in the factory gases." - BAAP

530. Weill, H., Ziskind, M., Derbes, V., Lewis, R., Horton, R.J.M., and McCaldin, R. O.: Further observations on New Orleans asthma. J. A.M.A. 8:184-187 (Jan.) 1964.

Acute asthma outbreaks associated with point sources of air pollutants, i.e., burning city dumps, have been identified. In a recent outbreak, air samples were collected, and aqueous extracts of the material were tested on outbreak patients, allergic students, and controls. Intradermal testing separated the students with asthma and hay fever histories from the controls. There was a very high incidence of positive intradermal reactions among known outbreak patients (85%). Students with currently symptomatic asthma had a significantly higher rate of reaction than symptomless members of the asthma group. Further studies are planned to isolate one or more substances that may be responsible for these asthmatic outbreaks. - PHEA

531. Wilkins, E.T.: Air pollution - some chemical and physical aspects of its effects on living material. In: The Effects of Air Pollution on Living Material. Symposia of Biology, No. 8, 71-80, London. The Institute of Biology, 1959.

Many regulatory acts to control air pollution have been instituted over the years beginning with the Alkali, etc., Works Regulation Act of 1863 which, after many amendments, is currently in operation. The Clean Air Act began in 1956. Since 1928 a cooperative project has been in operation to carry out research into the amount, nature, and prevention of air pollution and routine measurements of deposited matter, smoke, and sulfur dioxide are made on a continuing basis. At the present time the use of coal has increased to about 200 million tons, with an additional 20 million tons of oil. Present emissions of dust, smoke, and sulfur dioxide resulting from the use of these fuels have been estimated at about 0.8, 2.0, and 5.0 million tons a year, respectively. Table 1 in the text shows that the air of cities and industrial areas, in which a large proportion of the population lives, may provide about 10 times as much deposited matter plus 10 times as much sulfur dioxide plus 50 times as much smoke, as that of the countryside. Air contaminants from motor vehicle exhausts, are also a major problem. A short table is given in the text showing approximate composition of motor vehicle exhaust gases and toxic limits of concentration for 8 hours of exposure. Also discussed briefly are the smog studies of December 1952, 1955-56, and 1957-58. The author states that another possibility which arises from the theory that the irritation of the lungs by atmospheric pollution is due to acid gases of particles, is that of giving relief to chronic bronchitics and other susceptible persons by neutralizing the acidity with carefully controlled amounts of ammonia gas. - APCA

532. Wilkins, E.T.: Air pollution and the London fog of December 1952. J. Royal Sanit. Inst. 74:1-15, 1954.

This is a discussion of the air pollutants present during the Dec., 1952 London smog and their significance by the officer-in-charge, Atmospheric Pollution Section of the Fuel Research Station of the Department of Scientific and Industrial Research, London which cooperated in the investigation by collecting all available data on the concentrations of pollutants in different parts of the affected area.

The sources of air pollutants in town air, the meteorological conditions for fog formation and the methods used in the pollution measurements are reviewed. The daily smoke and SO_2 concentrations for Dec. 2-10, 1952 are tabulated showing maximum concentrations of 3-10 times the normal values for smoke and 3-12 times the normal for SO_2 to have occurred from Dec. 5-9 at individual sites as compared with the mean values for Dec., 1951. A comparison is made of smoke and SO_2 concentrations in London for Dec. 5-9, 1952 and Nov. 26 - Dec. 1, 1948 when severe smog also occurred. In general, the maximum and mean concentrations of both smoke and SO_2 in 1948 were about 50 and 70% of the 1952 values. A comparison of pollution in 1952 at the London sites, at sites in 7 towns which reported fog on 2 or more days during the smog period and at 8 towns which reported no smog showed appreciable increase of both smoke and SO_2 above normal even where no fog was reported. Probably, therefore, inversion conditions causing pollution increases were general even though there was no persistent fog in some of the affected areas. The greatest concentration of pollution occurred over the Westminster area with a zone of lesser concentrations spreading along the riverside areas. The presence of other possible pollutants, i.e., CO, CO_2, H_2SO_4 mist and tar, which were not measured, is discussed. The mortality of the period is discussed with a graphed illustration of the striking parallelism between the death rate and the concentrations of SO_2 and smoke. A secondary, but more extended peak in the mortality curve is noted for Jan. and Feb. Although others had attributed this to factors other than smog, including an outbreak of influenza, the author notes that during this period there was again a generally rising level of pollution to twice the normal value. He concludes that this was a second pollution shock to Londoners with resistance lowered by the earlier smog.

Since this smog was the most disastrous in the past 80 yrs., the question is raised whether it was due to freak meteorological conditions or to change in character or amount of any one pollutant or to both. Two factors are mentioned in this connection. One is the increasing concentration of SO_3 from both direct emissions and the oxidation of SO_2 in the atmosphere by the presence of oxides of N and certain types of particles acting as catalysts and O_3 with the subsequent formation of H_2SO_4 mist; all these reactions are favored during fog conditions. The 2nd is the exceptionally sticky or tarry nature of the grime which Londoners reported settled from the smog attributed to the increased use of a type of domestic open-fire designed to stay alight all night, and thus emitting smoke and distillation products at night. - Author's Sum.

533. Zanetti, W., Bisbini, P., and Cutrufelli, F.: Suspended and sedimentable dust in the city of Bologna. Nuovi ann. igiene microbiol. (Rome) 11:201-214 (May-June) 1960.

Research studies were carried out on the behavior of suspended and easily sedimented dust in the atmosphere of the city of Bologna, over the period of Mar. 1959-Mar. 1960. Suspended dust was studied from the following points of view: daily and seasonal variations, influence of meteorological factors, and determination of the size and characteristics of the particles by microscopic examination. Dust collections were made at 6 different locations in the city from 9:00 A.M. to noon and from 3:00 to 6:00 P.M. Table 1 lists the average monthly values for the 2 collecting periods at each of the 6 zones. These values ranged from a low of 89 particles/$cm.^3$, in zone 1 in the center of the city in Jan. 1960, to a high of 2418 particles/$cm.^3$, in zone 2 also in Jan. The average values of all the observations, grouped according to the 4 seasons of the yr., were: spring, 619 particles; summer, 195 particles; autumn, 756 particles; and winter, 1750 particles. In table 2 is given the percentage of particles to be found in the suspended dusts in the size ranges in <1, 1-5, and 5 µ, for each month of the study. In tables 3, 4, 5, and 6 are given various data on the quantity, in tons/km.^{2}/month of the sedimented dusts and information on their composition; the composition of the dust during various months; the percentage composition of the total insoluble substances; and the percentage composition of the total soluble substances. A graph shows the relationship between the sedimented material (soluble and insoluble), the suspended dusts, and precipitation. - APCA

534. Yanysheva, N. Ya.: The effect of air pollution from power and chemical plants on health. Gig. i Sanit. 8:15-20, 1957. In: Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U. S. Department of Commerce, Office of Technical Services, Washington, D. C., vol. 1, Jan. 1960, pp. 98-104.

A study was made in 1957 of the effect of industrial discharges on the health of inhabitants of two adjacent communities, one having a relatively clean atmosphere and the other having high levels of air pollution.

A comparative medical study was made of selected groups of adults from each of the communities. In addition 613 children of lower school age were also selected. These groups were studied on a comparative basis with regard to sex, age, duration of residence, type of occupation and general living conditions.

The results showed that morbidity per 100 was 1.8 times as high among the population of community no. 1 than in the control section; there were 81 cases per 100 in community no. 1 and only 45.3 in the control section. Cases of upper respiratory injury among the adults of community no. 1 were twice as numerous as in the control section, and injuries to the nervous system 4.5 as frequent. Diseases of the respiratory tract among the population of community no. 1 were almost entirely limited to the upper respiratory parts.

535. Zeidberg, L.D., Prindle, R.A., and Landau, E.: The Nashville air pollution study. I. Sulfur dioxide and bronchial asthma. A preliminary report. Am. Rev. Resp. Dis. 84:489-503 (Oct.) 1961.

A group of 84 patients (49 adults and 35 children) with bronchial asthma reported 3647 asthmatic attacks during 27,440 persons-days of observation or an over-all attack rate of 0.113/person-day. In adults the asthmatic attack rate varied directly with the level of sulfation in their residential environment. Attack rates on days with the highest and lowest sulfur dioxide values were significantly different. When the attack rates were shifted over 1 day to take account of possible delay effects, the differences were even more significant. The influence of temperature, humidity, and barometric pressure on the asthmatic attack rate could not be demonstrated but wind velocity showed an inverse relationship. Pulmonary function tests indicated that the subjects with a 1-second times vital capacity of less than 50% of the normal vital capacity had significantly higher attack rates than patients with more than 75% function. - APCA

536. Zeidberg, L.D., Prindle, R.A., Balchum, O.J., Sussman, S., and Toyama, T.: The Nashville air pollution study. II. Pulmonary Anthracosis as an Index of Air Pollution. Am. J. Pub. Health 53:185-199 (Feb.) 1963.

In 641 consecutive autopsies performed at Vanderbilt University Hospital during the years 1953 to 1956, excluding those on subjects under five years of age, microscopic evidence of pulmonary anthracosis was sought. The deposition of anthracotic pigment increased with age; it was more severe in males than in females; and in Nashville residents compared with out-of-city dwellers. Among Nashville residents it increased with length of residence in the city and was more severe, at least in females, in those who had lived in the more polluted areas of the city. The influence of occupation could not be demonstrated because of insufficient occupational history. No association was found between anthracosis and specific pulmonary or cardiac symptoms or pathology: Pulmonary anthracosis appears to reflect an individual's exposure to environmental air polluted with coal dust. - APCA

537. Zeidberg, L.D., Prindle, R.A., and Landau, E.: The Nashville air pollution study. III. Morbidity in relation to air pollution. Am. J. Pub. Health 54:85-87 (Jan.) 1964.

A method for studying the association of air pollution and morbidity in an urban population has been described and its limitations have been discussed. Direction correlations of total morbidity and levels of pollution as measured by the soiling index and 24-hr. SO_2, were observed among individuals 55 yrs. old and older of the middle socioeconomic class. Direct correlations for the same aerometric parameters were also noted for cardiovascular diseases, but not for any other specific group of diseases. Refinements of analyses to differentiate home and occupational environment influences on morbidity, revealed that housekeeping white females manifested direct correlations of pollution and total morbidity for all aerometric parameters while working females showed none. Non-white females tended to show direct correlations in both housekeeping and working groups. The effect of pollution on specific diseases of the respiratory, cardiovascular, or gastrointestinal systems could not be demonstrated because such breakdowns produced numbers too small for valid analysis. - APCA

538. Zeidberg, L.D., Horton, R.J.M., and Landau, E.: The Nashville air pollution study: V. Mortality from diseases of the respiratory system in relation to air pollution. USDHEW, PHS, Div. of Air Pollution, 1963.

1. The plan of a study of respiratory disease mortality in relation to air pollution, designed to control socioeconomic factors as well as degree of exposure to air pollutants, has been described.
2. With the exception of lung and bronchial cancer, mortality from other respiratory disease varied inversely with the socioeconomic class, when the degree of exposure to air pollutants was kept constant.
3. With the socioeconomic factor controlled, respiratory disease mortality was directly related to the degree of exposure to sulfation and soiling, except for lung and bronchial cancer, and for bronchitis and emphysema.
4. Age-specific respiratory disease mortality rates up to 65 years of age were directly related to the degree of exposure in sulfation. After 65 years, the highest rates were observed in the low pollution group.
5. At all levels of exposure to sulfation, respiratory disease mortality rates for males were higher than for females. The difference was especially marked for lung and bronchial cancer mortality.
6. With the exception of lung and bronchial cancer, respiratory disease mortality rates for non-whites and higher than for whites at high and moderate levels of exposure to sulfation.
7. The deviation of mortality for lung and bronchial cancer, and for bronchitis and emphysema from the pattern shown by other respiratory diseases has been discussed. - Authors' Sum.

6. EXPERIMENTAL HUMAN EXPOSURE TO SULFUR DIOXIDE

539. Amdur, M.O., Silverman, L. and Drinker, P.: Inhalation of sulfuric acid mist by human subjects. Arch. Indust. Hyg. & Occupat. Med. 6:305-313, 1952.

Normal human subjects of various ages inhaled concentrations of H_2SO_4 mist varying from 0.35-5 mg./m.^{3} through a face mask while resting. Particle size of the mist averaged 1μ. The retention of inhaled H_2SO_4 from 22 determinations averaged 77%. Changes in respiration in all the subjects were observed and measured by a pneumotachograph. Results on 5 subjects exposed to concentrations of 0.35 mg./m.^{3}, 5 to 0.4 mg./m.^{3} and 5 to 0.5 mg./m.^{3} showed increase in respiration rate, but with expiration taking a greater % of the total cycle and a decrease in tidal volume after exposure breathing returned to normal. Since retention of inhaled acid mist decreases when the respiration rate increases, these changes in respiration appear to be a reflex protective mechanism to prevent retention of the acid mist. At concentrations of 5 mg./m.^{3}, levels at which the acid mist was easily detected by all, changes were more pronounced but also more varied in nature. The main response at this concentration was a decrease in minute volume. Pneumotachographic tracings are given for various concentrations before, during, at end and after exposures. The possible significance of these findings is discussed. - APCA

540. Amdur, M.O., Melvin, W.W., Jr., and Drinker, P.: Effects of inhalation of sulfur dioxide by man. Lancet 2:758-759, 1953.

Fourteen healthy men, aged 28-58, breathed SO_2 in concentrations varying from 1-8 ppm, through a face mask while resting. The volume of expired air was measured in a spirometer, and the respiratory rate and pattern were measured by a pneumotachograph. Concentrations of 1-2 ppm were not usually detected. At 5 ppm most people complained of a slight feeling of dryness in the throat and upper respiratory passages, but could not actually "smell" it. Those exposed to 6-8 ppm definitely detected SO_2 in the air but became accustomed to it as the exposure increased. For each of the concentrations (1-8 ppm) tidal volume decreased, respiratory rate increased and pulse rate increased in the same general pattern. Graphs showing these changes for SO_2 concentrations at 1 ppm and at 5 ppm are given. Two men who worked daily in atmosphere containing $\geq$10 ppm SO_2 showed no changes when exposed to 5 ppm. The pneumotachographic tracings and a graph of total volume, respiration rate and pulse rate vs. minutes are given. No persons with pre-existing respiratory or cardiac disease were studied. - KB.

541. Anonymous: Toxic possibilities of sulfur purification. J.A.M.A. 119:854 (July) 1942.

Sulfur dioxide is primarily a respiratory irritant, and as little as 0.001 percent may produce coughing. Slightly higher concentrations may produce conjunctivitis, pharyngitis, and bronchitis. The tolerable limit of sulfur dioxide concentration is 10 parts per million. - BAAP.

542. Asset, G.: Effect of particle size and wind speed on nasal penetration of wind borne particles. A.M.A. Arch. Indust. Health 15:119-123 (Feb.) 1957.

Percentage nasal penetration of particles was studied as a function of particle size and wind velocity in dead dogs. The influent concentration of the aerosol flowing into the noses was determined by a sampler made in the shape of a dog's head. The nasal penetration, i.e., the ratio of the effluent concentration to that of the influent concentration, was significantly greater for the smaller particle size and for the smaller wind velocity. Values of nasal penetration are also presented based on the concentration of the affluent aerosol, i.e., the aerosol in the air moving toward the animal. These values are smaller than those obtained from concentrations of the influent aerosol. - APCA.

543. Atiskina, I.K.: The combined action on the body of small concentrations of sulfur dioxide gas and of high air temperature. Gig. i Sanit. 24:26-32 (Oct.) 1959.

The author has studied the prolonged, combined action on the body of sulfur dioxide and of the high temperature of the surrounding air. The investigation included a clinical blood test; analysis of protein fractions of blood serum by means of electrophoresis on filter paper; a determination of the phagocytic activity of blood leukocytes; and the vitamin C content of tissues. As a result of the investigations the following has been determined. The phagocytic activity of blood leukocytes in workmen who were investigated at a chemical plant in Shchelkovo was lower than in persons of a control group. When experimental animals inhaled sulfur dioxide gas at a concentration of 0.08-0.1 and 0.02 mg./l., at a temperature of 35-40°C., there was a fall in the phagocytic activity of blood leukocytes, anemia, and changes in the ratio of protein fractions of the blood serum. Inhalation by experimental animals of sulfur dioxide gas at a concentration of 0.005 mg./l. at the same temperature produced insignificant changes in the phagocytic activity of blood leukocytes; the blood picture and the general condition of the animals remained unaltered. - APCA.

544. Barnes, J.M.: Mode of action of some toxic substances. With special reference to the effects of prolonged exposure. British Med. J. pp. 1098-1104 (Oct. 28) 1961.

Intermittent or more continuous exposure to chemicals with a tremendous variety of biological properties is undergone by many people during their work in industry, their life in our cities, and even in the privacy of their homes. In some polluted atmospheres the quantities of toxic materials seem to border on those demonstrably hazardous. In others--for example, the field of food additives--most of the materials appear by current standards to be virtually harmless. In other situations, particularly where occupational exposure is concerned, the chemicals may produce some deviation from normal the significance and importance of which are at present not fully understood.

Unfortunately, there are only very limited resources available either in this country or overseas for the experimental study and proper analysis of the properties and mode of action of toxic substances. In recent years the balance of this effort has been grossly disturbed by the current clamour about the safety of chemicals used as food additives (Mulford, 1961). Increasingly greater laboratory facilities are being devoted to the carrying out of set procedures to show that substances almost biologically inert can be tolerated by rats and dogs for years on end. There are, however, still quite a number of really poisonous materials, particularly in the environment of those in certain occupations. It is surely important to see that, in this country at least, more attention will be paid to the problems presented by such materials.

545. Casarett, L.J., Some physical and physiological factors controlling the fate of inhaled substances. II. Retention, Health Phys. (London) 2:379-386 (May) 1960.

Particulate material deposited in the respiratory tract behaves in a variety of ways. Certain aspects of the behavior of particles in the respiratory tract are reviewed. Emphasis is placed on relatively insoluble particles, deposition in the parenchymal regions of the lung and on the phagocytosis and its part in the mechanisms by which the particles are removed from the lung. The fundamental mechanisms of clearance are discussed, with some emphasis on those aspects which are pertinent to the calculations of the radiation dosage to the lung as usually performed. 65 references. - APCA.

546. Dautrebande, L., Capps, R. and Weaver, E.: Studies on aerosols IX. Enhancement or irritating effects of various substances on the eye, nose and throat by particulate matter and liquid aerosols in connection with pollution of the atmosphere. Arch. Internat. Pharmacodynamie 82:505-528, 1950.

In preliminary experiments, 7 healthy human subjects (4 M and 3 F) were exposed for 10 min. to the following substances with and without oil aerosols, using various solvents (H_2O, alcohol, ether, $CHCl_3$) to test their eye, nose and throat irritating properties: tincture of capsicum, 10%; pepper berry extract; formaldehyde, 2%, 4%, and 8%; acrolein, 0.5% and 5 different organic peroxides, 5%. The mean relative humidity in the chamber was 38%±4%. The irritating compounds were dispersed either with an aerosol generator (mean size, 0.2-0.3μ) or by explosion to form aggregates of a size compatible to settling out in the nose, throat and eye (5-25μ). The subjective reactions for eye, nose and throat irritation were recorded as mild (X), moderate (XX) and severe (XXX), and these were summed up. Fresh mineral oil aerosols alone and the above irritants alone were not irritant to the eye, nose and throat, but were definitely irritant when both were simultaneously dispersed at corresponding concentrations. Also used motor oil aerosols alone were irritant. 8-18 normal persons at a time were exposed for 10 min. to each of the artificial atmospheres. These consisted of 0.2-0.5 ppm SO_2 or SO_3 alone, SO_2 or SO_2 with particulate matter (C black containing 10% diesel oil), with used oil aerosols, with used oil aerosols plus C black with NaCl aerosol or with distilled H_2O, and control experiments with C black (+10% diesel oil)alone, used oil aerosol alone and distilled H_2O. The subjective sensations were recorded as above and tabulated along with the other data. The following conclusions were drawn. (1) SO_2 (concentration ca. 0.5 ppm) and SO_3 (concentration ca. 0.2-0.5 ppm) with or without distilled H_2O aerosol produce practically no irritation of the eye, nose or throat. (2) SO_2 and SO_3 (concentration same or comparable to the other compounds) with ca. 0.07-0.30 ppm C black (with 10% diesel oil), with ca. 1.5-4.0 ppm used motor oil aerosols, or with C black + used oil aerosols, acquire irritative properties. (3) C black alone (0.2-0.3 ppm), used motor oil aerosols alone (1.3-2.0 ppm), or mixtures of both (in ca. comparable concentrations) are by themselves eye, nose and throat irritants. (4) NaCl aerosols (1.1-2.5 ppm) with SO_2 (0.5 ppm) and SO_3 (0.1-0.5 ppm) produce a definite ocular, nasal and pharyngeal irritation.

As applied to Los Angeles atmosphere where the above concentrations of these materials are found, it is possible to assume that the irritant gases and vapors detected there are probably not responsible, as such, for the eye irritation, but that air-suspended matter (either alone or carrying possible irritative gases or vapors), e.g., C black-like material, oily material or NaCl, is. This PM may either be of a highly adsorbent nature (C black) or be able to build up coalescent droplets or large aggregates (oil and NaCl)$\geq 5\mu$, which conditions favor the early settling out and the irritant action of the air-suspended material on the eyes, nose and throat. Temperature inversion conditions, which cause smog, are ideal for this. - KB.

547. Dautrebande, L., Shaver, J., and Capps, R.: Studies on aerosols XI. Influence of particulate matter on the eye irritation produced by volatile irritants and importance of particle size in connection with atmospheric pollution. Arch. Internat. Pharmacodynamie 85:17-48, 1951.

The eyes of 3 normal, trained male subjects were exposed for 3-min. periods to controlled atmospheres containing 0.002-0.019 mg./l. air of the following: mixed HCHO, HNO_3, H_2SO_4 aerosols alone ("vapors"); vapors plus particulate matter (PM), i.e., NaCl aerosols, silica suspensions, used motor oil aerosols; vapors plus PM without oil aerosols; vapors plus oil aerosols, without NaCl aerosols and fine SiO_2 dust; total PM alone, i.e., NaCl aerosols. SiO_2 dust, used motor oil aerosols; PM without oil, i.e., NaCl aerosols and SiO alone and used oil aerosols alone. The degree of subjective eye irritation, the degree of irritation of the oculonasal ducts, the amount of lacrimation and the blink rate were observed every 15 sec. The results along with concentration of the various constituents are tabulated and the following conclusions drawn. The reaction of a given atmosphere may vary largely from 1 subject to another. The reaction of the same subject to a given atmosphere may vary from 1 exposure to another. PM (NaCl aerosols, fine SiO_2 dust and used oil aerosols) added to HCHO, H_2SO_4 and HNO_3 aerosols regularly and notably enhanced the eye irritation on all 3 subjects. NaCl aerosols and fine SiO_2 dust without used oil aerosols added to the vapors enhanced the irritation produced by the vapors in every case on 2 subjects and inconsistently on the 3rd subject who had a high irritation threshold. HCHO, HNO_3, H_2SO_4 aerosols plus used oil aerosols (without SiO_2 dust and NaCl aerosols) produced a stronger irritation than with vapors alone, on the 2 subjects exposed. PM alone required a much higher concentration (0.02 mg./l.) to produce eye irritation than when the vapors were present in the air. NaCl aerosols and fine SiO_2 dust (without the vapors and oil aerosols) did not produce any noticeable irritation even at concentrations 40 times above the threshold (0.8 mg./l.) as found for irritant vapors. Used oil aerosols alone produced an ocular irritation during the 3-min. exposure, but only at a much higher concentration than when the vapors and PM were present in the various combinations. Electron microscope photographs were taken of aerosols containing HCHO, HNO_3, H_2SO_4, NaCl, used oil, SiO_2 and C black (India ink) at various concentrations (0.000001-0.000033 mg./l. air). The aerosols appeared in 3 states: (a) a very large number of discrete shadowed particles, mean size ca. 0.55 µ; (b) long (1-7µ) well-shadowed chain aggregates containing a very large number of individual small particles; (c) nonshadowed coalescent, spreading aggregates (1-10µ). The collodian background covered by the flat aggregates seemed in most cases to have been somewhat corroded or "digested" by the material collected and is considered to be the most responsible for the eye, nose and throat irritation. H_2O emulsions of used motor oil at similar concentration gave practically the same photographic appearance. Particulates this size (c) have been found in Los Angeles atmosphere and are known to be retained in the upper respiratory tract. - KB

548. Dautrebande, L., Beckmann, H., and Walkenhorst, W.: Studies on deposition of submicronic dust particles in the respiratory tract. A.M.A. Arch. Indust. Health 19:9-17 (April) 1959.

In a previous paper, the characteristics of the lung retention of coal dust particles (maximum size 5 µ; mean size 0.8 µ) were studied in three normal subjects. By comparing inspired air, global expired air, end of tidal air, and alveolar air, it was shown that the deposition rate of these particles as estimated by their counting in the global expired air and in the last portion of the tidal air was inversely proportional to the respiratory rate. On the other hand, the deposition rate of these coal dust particles in the Haldane-Priestley deep alveolar air was consistently observed to be above 90%, irrespective of the frequency or of the depth of breathing. As theoretically assumed by Findeisen and experimentally confirmed by Wilson and La Mer, Landahl, Tracewell and Lassen, and Altshuler, Yarmus, Palmes, and Nelson, it was also found that for every respiratory rate, from 3 to 32 per minute, the deposition of these coal dust particles in the lungs taken as a whole and at the level of the last portion of the tidal air, usually presented a minimum round about 0.5 µ. Such a shift toward a minimum followed by a reascending of the deposition rate could not be demonstrated in deep alveolar air samples. - Authors' Sum.

549. Doyle, G.J., Endow, N., and Jones, J.L.: Sulfur dioxide role in eye irritation. Arch. Environ. Health 3:657-667 (Dec.) 1961.

An eye irritation panel has been exposed to steady state reaction mixtures generated in a 520 ft. irradiated stirred flow reaction chamber. The reactants for 1 set of exposures were usually 0.2 to 2.0 ppm. by vol. of olefinsand nitrogen dioxide in purified air. Reaction residence times ranged from 1 to 2 hrs. Sulfur dioxide was used as an additional reactant (at a concentration of about 0.1 ppm.) in a comparable set of experiments. The reacting mixtures were evaluated for relative eye-irritating ability with and without sulfur dioxide. The concentration of reactants and some of the reaction products were determined, and the light scattering and the particulate content of the mixtures were measured. The rate of response to an eye irritant is a function of the chemical nature of the irritant or irritants. Ethylene and propylene, olefins important in auto exhaust, can produce significant eye irritation at realistic atmospheric concentrations. With the slow reactor, ethylene, significant eye irritation was developed by using larger residence times than were used with other olefins. 22 references. - APCA

550. Elfimova, K.V. and Shaskov, V.S.: The effect of sulfur dioxide gas in the atmospheric air on some biochemical indexes of the blood in man. Gig i Sanit. 25:18-22 (March) 1960.

The pollution of the atmospheric air with sulfur dioxide has been investigated in 2 residential districts of an industrial town. Biochemical blood tests for the presence of SO_2 were performed on the residents of these districts. Investigations embraced healthy persons with no occupational contact with SO_2, and having resided in the district for a period of not less than 4-5 yrs. In District A the average air pollution with sulfur gases was found to be a max. of 12.8 mg./m.^{3} and an average of 2.0 mg./m.^{3}. In District B the max. was 1.4 mg./m.^{3} and the average 0.83 mg./m.^{3}. In biochemical tests of the blood of 62 persons in District A, 40 showed no SO_2 present, 5 a trace, and 17 a range of 0.01-0.02 mg. %. In the 30 persons in District B, 28 showed no SO_2 present, and 2 a trace. The ascorbic acid level for the same groups of people showed, for District A, 49 with 0.2-0.5 mg. % and 13 with 0.6-0.8 mg. %. District B had 26 with 0.2-0.5 mg. % and 4 with 0.6-0.8 mg. %. The results obtained showed that the biochemical analyses are very useful for hygienic evaluation of the effect of industrial discharges on the health of the population.-APCA.

551. Evans, E.E.: An X-ray study of industrial gases on the human lung. Radiology 34:411-424, 1940.

Serial X-rays of the chests of a large number of men exposed to 4 different type chemicals were taken over a period of 5 yr. All operational procedures were modern, but occasionally leaks and other exposures to low concentrations occurred. The first group of 35 men (average age - 38 yr.) was exposed to Cl_2 and HCl in the manufacture of these products. The average service in the industry was 9.5 yr.; that in the Cl_2 area, 6.4 yr. Comparison of the chest X-rays showed no increased pulmonary fibrosis over the 5 yr. The second group of 18 men (average age -44 yr.) was exposed to SO_2 and SO_3 in the manufacture of H_2SO_4. The average service in the industry was 13.5 yr. and in the area, 10.7 yr. Comparison of X-ray films showed not only no increase in pulmonary fibrosis, but, in some cases, less fibrosis. The 3rd group consisted of 74 men (31.7 yr. average age) who were exposed to H_2F_2 acid fumes and its combination products. The average service in the industry was 4.9 yr., and in the area, 2.7 yr. There have been many operating difficulties in this area and the fumes have been severe at times. More recently operational procedures have been improved. But the X-ray films showed no pulmonary fibrotic increase. The 4th group of 41 men (average age - 39.7 yr.) was exposed to $COCl_2$, $POCl_3$ and PCl_3. Average service in the industry was 10.5 yr.; in the area, 8.4 yr. Again there was no increase in pulmonary fibrosis, and, in some cases, less fibrosis. The workers who have not been ill have also been observed through an insurance plan and it was found that there is no higher death rate from pneumonia and other pulmonary infections in this group than that recorded for the other plant employees. - KB

552. Flury, F.: Absorption of gases by the skin. Festschr. Zangger 2:836-845, 1934.

The absorption of gases by the skin is influenced by various factors, such as: solubility (in lipoids and H_2O), temperature, size and conditions of skin area (increased absorption by warm, moist skin), concentration of the gas and the reactive capability of the absorbing organ. Following absorption and temporary storage of the gases in the various cell layers, they enter the blood and lymph systems. The main ports of entrance are the sebaceous glands, less important are the sweat glands. The keratin layer is not completely impervious. The principal protective properties of the skin against the various injuries are discussed. A review of gases as to their absorbability is given. The following gases are absorbed: O_2, Cl_2, Br_2, H_2S which latter may result in percutaneous poisoning, NH_3, CO_2 the absorption of which is harmless, Hg, $Pb(C_2H_5)_4$ in a liquid state, hydrocarbons and their derivatives. C_2H_5OH is probably absorbed, and in solution it penetrates the skin. HCN is easily absorbed by human and animal skin, and even small amounts are highly toxic. C_6H_5OH is absorbed in the liquid state; $C_6H_5NO_2$ and the related aromatic gases are probably absorbed, but it has not yet been demonstrated. $C_6H_5NH_2$ is absorbed in negligible amounts; following the uptake of nitrochlorobenzene, slight symptoms of poisoning have been demonstrated in cats. N is not absorbed; the absorption of $(C_2H_5)_2O$ and of $CHCl_3$ is doubtful. The absorption of SO_2 has been demonstrated in the broken skin of horses, but not in humans; it is an irritant. The insolubility of CO in H_2O practically prevents the absorption of the gas by the skin. The author reports that a 15-min. exposure of human skin to 2% CO did not result in its absorption by the skin. However, increased and dangerous amounts of the gas might be absorbed when workers are in contact with technical gas mixtures (40% CO) for a prolonged period of time, particularly when doing heavy work in a warm and moist atmosphere. - KB

553. Frank, N.R., Amdur, M.O., Worcester, J., and Whittenberger, J.L.: Effects of acute controlled exposure to SO_2 on respiratory mechanics in healthy male adults. J. Appl. Physiol. 17:252-258 (March) 1962.

Eleven healthy, adult, male volunteers were exposed on separate occasions to average levels of sulfur dioxide of 1, 5, and 13 ppm. The subjects were seated in a body plethysmograph, breathing spontaneously by mouth while measurements were made with an esophageal catheter. Exposures lasted 10-30 minutes, and, for each subject were spaced at least 1 month apart. With one exception and a group showed no significant increase in pulmonary flow resistance at the lowest concentration of gas. At both 5 and 13 ppm, flow resistance was elevated, the change being greater at 13 ppm. The change occured within 1 minute of exposure,increased after 5 minutes but, on the average, showed no further change after 10 minutes. Four subjects were exposed to 5 or 13 ppm of SO_2 for 30 minutes without exhibiting increases in flow resistance beyond the first 10 minutes. There were no consistent changes in pulmonary compliance, tidal volume, breathing frequency, or pulse rate. The functional residual capacity increased slightly during exposure to 13 ppm. - Authors' Abst.

554. Frank, N.R., Amdur, M.O., and Whittenberger, J.L.: A comparison of the acute effects of SO_2 administered alone or in combination with NaCl particles on the respiratory mechanics of healthy adults. Internat. J. Air & Water Poll. 8:125-133 (Feb.) 1964.

Changes in the pulmonary flow resistance (Rl) of healthy male adults, induced by three levels of SO_2: 1-2, 4-6, and 14-17 ppm, were compared when the gas was administered alone or in combination with submicronic sodium chloride aerosol. The subjects were seated in a volume-displacement body plethysmograph, breathing by mouth. At least one month transpired between exposures. No systematic differences were found between the responses to the gas alone and to the gas-aerosol mixture. Essentially the same dose-response relations occurred in both circumstances: that is, the group showed no change in Rl during exposure to 1-2 ppm of SO_2, and showed a smaller increase to 4-6 ppm than to 14-17 ppm. In a second type of experiment the gas and gas-aerosol mixture were administered one after the other, separated by a 15 minute period of room-air breathing. The response to the second exposure whether it was the gas alone or the mixture--was smaller than the response to the first exposure. - APCA

555. Gerin, C.: Experimental contribution to the chemico-toxicological investigation of sulfur dioxide. Arch. Antropol. crim. 54:413, 1934.

This paper on in vitro and in vivo studies to determine methods for finding evidence of sulfur dioxide poisoning at necropsy discusses the various methods for testing for sulfur dioxide in vitro and the changes that sulfur dioxide may undergo. Sulfur dioxide, for example, may form sulfuric acid, or it may combine with hydrogen sulfide to form free sulfur or water. Hydrogen sulfide is apparently formed as a product of putrefaction after death. Since sulfur dioxide is a gas, it is readily eliminated from the body. It changes to sulfuric acid in contact with the oxygen of the blood and the moisture of skin membrane.

The problem then was to determine actual sulfur dioxide poisoning and eliminate the possibility of getting positive results due to release of sulfur from protein breakdown or poisoning due to sulfuric acid or hydrogen sulfide. Since there is also a danger in confusing hydrogen sulfide and sulfur dioxide, the author removed hydrogen sulfide with lead acetate. Alkaline carbonate is added to transform organic compounds of sulfur dioxide into soluble alkaline sulfites. For positive results, immediate post mortem study is required in chronic poisoning. In acute poisoning the investigation is positive only if made within 48 hours after the death. - BAAP

556. Greenwald, I.: Effects of inhalation of low concentrations of sulfur dioxide upon man and other mammals. A.M.A. Arch. Indust. Hyg. & Occupat. Med. 10:455-475, 1954.

A review of the literature on the effects of the inhalation of low concentrations of sulfur dioxide and of sulfuric acid upon man and mammals may be summarized as follows.

The various species differ greatly in susceptibility, rats being the most resistant and guinea pigs the least. Man is much more sensitive than is the guinea pig.

Young guinea pigs are much more sensitive to mists of sulfuric acid than are mature animals (one and one-half years).

The therapeutic use of sulfur dioxide, particularly in the treatment of diseases of the skin, in man and in animals has been recalled.

Continued exposure of animals to high concentrations (100 and 500 ppm) of sulfur dioxide lowered their resistance to infection with a variety of micro-organisms and lessened the formation of anti-bodies. Similar exposures to 50 ppm had no such effect.

Concentrations of sulfur dioxide at 1 ppm and of sulfuric acid at 0.5 mg./m.^{3} are not detected by human beings but do alter the respiratory pattern.

Very few healthy adults find concentrations of sulfur dioxide up to 5 ppm or of sulfuric acid at about 1 mg./m.^{3} objectionable. Concentrations twice as great are apt to be irritating.

Reasons are given for regarding as probably excessive for prolonged exposure the present maximum allowable concentration of 10 ppm of sulfur dioxide.

There is no good evidence that either chronic exposure to concentrations below 5 ppm of sulfur dioxide or occasional exposure to higher concentrations, so long as these are not overpowering, have any ill effect upon healthy men.

The possibility that such persons are adversely affected by simply fog should be investigated, if possible. Adequate statistics might be available from Brighton, England.

The possible modifying action of other contaminants, particularly aerosol sand dusts, should be investigated more thoroughly.

Sulfur dioxide and sulfuric acid can neither be held responsible for the Meuse Valley, Donora, and London episodes nor be absolved from at least partial responsibility for them. - Authors' Abst.

557. Haggard, H.W.: Action of irritant gases upon the respiratory tract. J. Indust. Hyg. 5:390-398, 1924.

This discussion of the action of irritant gases on the respiratory tract includes the topics of chemical irritation and vital reaction; determination of locus of action;

protective reflexes; relative seriousness of injury to different levels of the respiratory tract and the chronic effects. The relation between the physical properties of irritants and their site of action in the respiratory tract and subsequent symptomatology is tabulated for NH_3, HCl, HCHO, H_2SO_4, SO_2, Br_2, Cl_2, phosgene and N perioxide. - Authors' Abst.

558. Hayashi, M.: Studies on sulfur dioxide poisoning. 1. The influence of sulfur dioxide on the peripheral hemogram. J. Sc. Labor 31:641-650 (Oct.) 1955.

The author concludes from his investigation at a smelter of the Matsuo Mine that the concentration of sulfur dioxide is ordinarily 3-8 ppm, and frequently rises to 60-100 ppm. The phenomenon of adaption to sulfur dioxide is only transitory when judged from a long-term viewpoint. The number of red blood corpuscles and the amount of hemoglobin increase slightly during the first five years of employment. After ten years there is a tendency for the Price-Jones' curve to shift to the left and for the red blood cell volume to increase. There is no apparent change in the white blood cells. - English Sum.

559. Henschler, D., Stier, A., Beck, H., and Neumann, W.: Olfactory threshold of some important irritant gases (sulfur dioxide, ozone, nitrogen dioxide) and effect on man when exposed to low concentrations. Arch. Gewerbehyg. Gewerbepath. 17:547-570, 1960.

In order to establish maximum values for irritating gases contained in the air, experiments were undertaken with sulfur dioxide, ozone and nitrogen dioxide.

About 10 to 14 persons were exposed to slowly increasing concentrations of gases, in addition to various degrees of humidity.

The persons exposed to various degrees of sulfur dioxide reported that only a few were aware of odor at an exposure to 0.5 ppm; by exposure to 1 ppm sensation of odor or taste was apparent to 75%, and all of the persons perceived a sense of odor or taste at the exposure to 2.5 ppm. Coughing was caused by 5 ppm and an exposure to 2.5 ppm of half hour duration caused the feeling of discomfort. What was perceived at first as odor developed gradually into a sensation of taste. High humidity had no apparent influence on quality and intensity of the observation.

The olfactory threshold for ozone is below the lowest concentration tested, 0.02 ppm. At a concentration of 0.1 ppm odor disappears within 30 min. Nose and throat irritation become apparent at exposures to 0.5 ppm. A few minutes of exposure to 1 ppm are very unpleasant. Increase in humidity does not influence the sense of smell or the irritating phenomena.

Odor was perceived by a few members of the tested persons at a concentration of 0.1 ppm of nitrogen dioxide, but by all at concentration of 0.4 ppm. The sense of smell disappears at continuous exposure to even high concentrations (up to 20 ppm) within a few minutes. But the sense of smell was restored after exposure to normal air. Only at the initial exposure irritation of the nose and throat were noticed, but not after several exposures. With the concentration increasing from 0 to 27 ppm within 54 min. neither smell nor irritation was perceived. Increase in relative humidity from 60% to 80% in 1 ppm NO_2 increased the irritating symptoms, and odor was perceived again. This quick adaption to relative high concentrations of nitrogen dioxide explains the fact that there is hardly a danger signal concerning "nitrous gases" which explains some of the contradictions to be found in the literature on the effect of these nitrous gases.

The difference in the effect of these three irritating gases are presented and statistically documented. The results are of importance in the establishment of maximal allowable concentrations for long term exposures, and also for short periods of increase of the medium standard values.

The individual characteristics of various gases have to be considered separately and there is no pattern according to which to proceed. - Authors' Sum. translated.

560. Hine, C.H., Hogan, M.J., McEwen, W.K., Meyers, F.H., Mettier, S.R., and Boyer, H.K.: Eye irritation from air pollution. J. APCA 10:17-20, (Feb.) 1960.

Eye irritation remains one of the major demonstrable ill effects of community air pollution. Experimental work reported in this paper does not demonstrate any objective evidence of histologic or biochemical change following exposure to relatively high concentrations of single or combined pollutants or artificial smogs. Measurements using human panels, by a number of groups, have contributed to a further understanding of the factors which lead to the formation of the eye-irritating components of polluted air, even though these have not as yet been identified. - Authors' Sum.

561. Jaensch, P.A.: Symptomatology and therapy of eye injuries caused by hydrogen sulfide. Arch. Gewerbepathol. Gewerbehyg. 1:397-407, 1930.

The injurious effects of H_2S on the organism, recognized in Germany as a compensable disease, include not only severe cases of H2S poisoning but also, more frequently, eye injuries. Due to the pain and the irritating effects involved, they usually force the affected person to leave the exposure, thus preventing more severe action of H_2S. Experiments involving both humans and animals exposed to the gas, the occurrence of the keratitis, wherever there is an exposure to H_2S, as well as a decrease in incidence as soon as the exposure is mitigated (e.g., by improvement of ventilation) give evidence of the causative role of H_2S. In viscose (artificial silk) manufacturing plants, the workers in the spinning room are those mostly affected, since the exposure is almost exclusively confined to this step of the process. During a period of 3 mo., the author examined 43 workers. On the basis of his findings, the following clinical picture was established: the epithelial layer of the cornea shows stippling, confluent opaque spots, or, in severe cases, vesicles which may burst causing epithelial defects detectable with fluorescein. Further symptoms are blepharospasm, photophobia, appearance of haloes around the lights and secondary conjunctivitis. The degree of pain and the duration of the disease depend on the extent of the injury. Both pains and blepharospasm often occur only several hours after leaving the exposure. The fundus oculi is not affected, and the corneal sensitivity is impaired only in the most severe cases; no corneal scars remain. The disease, keratitis superficialis punctata, is due to the direct action of the H_2S in the air rather than to accidental introduction of some H_2S-containing substance into the eyes by hand or to the effects of tiny droplets which might have come into the eyes. In experimental rabbits of various ages, the experimental exposure for several mo. to the atmosphere in the working room did not affect the cornea, even when their resistance was lowered by retrobulbar injections of alcohol. However, fresh H_2S water sprayed or H_2S gas acting directly upon the cornea caused opaqueness within 10 min. and epithelial defects within 30-40 min. Threads prepared in the following manner were placed for 24 hr. on the corneae of anesthetized rabbits, the eyelids being closed by sutures: (a) cooked, freed from H_2S and CS_2 and dried, (b) treated in the coagulation bath before reaching the bobbin, (c) taken from the "cake" (the latter 2 kinds were moist). These results were obtained: (a) benign, superficial ulcers, healing within 507 da., leaving gray macules, (b) deep ulcers followed by leucomata and (c) whiteness of conjunctiva, on 3rd day perforation of the cornea. Under the same conditions, sterilized surgical silk threads did not cause any changes in the eyes of controls, thus ruling out the mechanical action as causative factor. Recommendations are given as to therapy (local) and precautionary measures. MAC is given as 500 ppm.- KB

562. Lawther, P.J.: Effects of inhalation of sulfur dioxide on respiration and pulse rate in normal subjects. Lancet 269:745-748 (Oct. 8) 1955.

No consistent changes in the tidal volume, respiratory rate, or pulse rate followed the inhalation for ten minutes of air containing 5 ppm and 10 ppm of sulfur dioxide by 18 persons, of whom six lived in rural Kent. Six town dwellers inhaled the gas mixtures both from the mouth piece and from a face mask. The series consisted of 72 experiments. In an additional series no consistent changes were seen in six town dwellers, who inhaled 20 ppm of sulfur dioxide by mouth. Two apparently healthy persons developed audible signs of bronchospasm during the inhalation of 10 ppm of the gas. This effect is being studied. - Authors' Sum.

563. Lehmann, K.B.: Experimental studies on the influence of technically and hygienically important gases and vapors. VI. Sulfurous acid. Arch. Hyg. 18:180-191, 1893.

The investigation reported here was carried out in a plant producing sulfite pulp by cooking of coniferous wood with $CaSO_3$ in aqueous H_2SO_3: 24 g. "free" H_2SO_3, 12 g. CaH_2SO_3/1. H_2O, the cooking time being 18 hr. The digester was 20 m. high, and windows and doors provided the only ventilation. The following temperatures were measured (C): outside, -4°, 1st floor, 3-9°, 2nd floor, 25-29°, and 3rd floor, 3-4°. Considerable emittance of SO_2, due to leakage, was noticeable throughout. Analysis of air samples, collected on 2 occasions with a time interval of 16 da., by the $Na_2S_2O_3$ method, gave the following maximum values of SO_2 (in volume %) for floors 1 and 3: (a) 1 - 0.0142, 3 - 0.0367; (b) 1 - 0.0315 and 3 - 0.022. No workers were exposed for prolonged periods of time on the 2nd floor. The following effects on the various concentrations of SO_2 on the author and 2 other persons not accustomed to the exposure to SO_2 are described (SO_2 in volume %): 0.0065 - 0.0115, barely noticeable for the 10-15 min., 0.014 - 0.0147, distinctly noticeable, producing no effects for ½ hr., 0.022, distinctly noticeable but tolerable and 0.0304, severely irritating to the nasopharyngeal mucosae within a few min., the effects diminishing after 10 min. (total exposure was 15 min.). No irritation of the eyes was noticed, no sequelae remained. For workers accustomed to the exposure to SO_2, concentrations of 0.03-0.04 were noticeable but tolerable and without irritating effects. 30-40 workers from both day and night shifts, ranging in age from 20 to 51, in duration of exposure from ½ to 8 yr., were examined. No complaints about or clinical signs of chronic effects on the following organs were found: respiratory system, eyes, gastrointestinal tract and teeth. No other changes attributable to the exposure under normal conditions were detected; however, there were some incidents of accidental exposure to high concentrations of SO_2, due to sudden leakage, which had resulted in burns, corrosions and pneumonia or bronchitis. The author's recommendations were confined mainly to suggestions with regard to improvements in ventilation. - KB

564. Lehmann, K.B.:: Recent studies on the quantitative absorption of some poisonous gases by the various parts of the respiratory tract in animal and man. Ammonia, hydrochloric acid, sulfurous acid, acetic acid, carbon disulfide. Arch. Hyg. 67:57-98, 1908.

The following methods were employed in the study of the absorption of inhaled gases in human subjects, cats and rabbits: (1) aspiration method: simultaneous collection of both inspired and expired air in inhalation chamber, (2) bottle method: nasal inspiration from one bottle, oral expiration into the other, (3) wash bottle method: inspiration from one wash bottle, filled with aqueous solution of the known gas, expiration into the other, filled with absorbent (inspiration as follows: a. by mouth into lung; b. nasally into lung; c. sucking in by mouth and blowing out by mouth, as in smoking), and (4) method using Muller's values (for animal experiments only): similar to (3), the valves being used to control the connection between respiratory tract and wash bottles (inhalation through either tracheal cannula or tubes inserted into the nose). The following summarizes the information given on the gases inhaled, their concentration, inhalation times and methods, as well as % and location of absorption, in that sequence.

A. Experiments with human subjects. NH_3, at 0.1-0.3 N throughout, 20 min., method 3c: 79-87.8% absorbed, of which 63% were found in the sputum, the rest in the oral cavity; 5-10 min., method 3a: 91% absorbed, in sputum 70%, rest in oral and pharyngeal mucosae; 20 min., method 3b: 100% absorbed, in sputum <6%, the rest in nasal mucosa. HCl, 0.29 mg./1., 20 min., method (2): 96% absorbed; 0.36 mg./1., 5 min., 89% absorbed. SO_2, 0.33 and 0.68 mg./1., 30 min., method (1): 70 and 65% resp.

absorbed. CH_3COOH, 2.0-3.0 mg./l., 3 min., method (1): apparently 100% absorbed. CS_2, 1.58-2.06, no time given, method (2), modified: 18.8-32.2% absorbed.

B. Animal experiments. NH_3, 0.1 N, 10-15 min., intratracheally (i.t.), 56% retained in lungs. HCl, 0.34-17.8 mg./l., 15-60 min., i.t. and intranasally (i.n.), 60-75% absorbed. SO_2, 1.09-16.7 mg./l., 15-30 min., i.t. and i.n., 46% absorbed. CH_3COOH, 7.9-87.7 mg./l., 30 min., i.t. and i.n., 70% absorbed. CS_2, 32.72-620.38 mg./l., 60 min., i.t. and i.n., 20.6% av. absorbed.

It is concluded: NH_3, depending on concentration and duration, even short exposures, e.g., occupational, may lead to an absorption of 75-100%. HCl, nasal inspiration by animals of up to 12.0 mg./l. air does not cause acid reaction in the trachea; no severe lung changes are observed. Absorption of low concentrations by humans is greater than that by animals. SO_2: animals show pulmonary edema, hemorrhages, occasionally emphysema; human subjects demonstrate severe eye and nasal irritation. One subject tolerated 0.38-0.68 mg./l. for ½ hr. CH_3COOH: the gas affected animals less than did HCl: tracheal hyperemia and occasional emphysema were observed; exposed persons showed mainly irritation. CS_2 caused slight bronchitis and rhinitis in exposed persons. As to the effects of inhalation of acid fumes in general, it is stated that both larynx and trachea proved well protected against effects of nasal inhalation. There was no difference in amounts absorbed between nasal and tracheal inhalation. The test methods employed did not warrant any definite conclusions as to absorption by the lungs. - KB

565. Mettier, S.R. Jr., Boyer, H.K., Hine, C.H., and McEwen, W.K.: A study of the effects of air pollutants on the eye. A.M.A. Arch. Indust. Health 21:1-6 (Jan.) 1960.

Rabbits were exposed to acrolein (2 ppm.), ozone (2 ppm.), sulfur dioxide (10 ppm.), and nitrogen dioxide (20 ppm.), acutely and chronically. Results are given in tables 2-7. The ophthalmologic and biochemical effects of these gases on intact and deepithelialized corneas were assayed. Under these conditions no effects were noticeable. The effect of these gases and persumable smog in general is at a lower subjective sensory level. 28 references. – APCA

566. Mettier, S.R., Jr., Boyer, H.K., McEwen, W.K., Ivanhoe, F., Meyers, F.H., and Hine, C.H.: Effects of air pollutant mixtures on the eye. Arch. Environ. Health 4:103-107 (Jan.) 1962.

Rabbits were exposed to the following air pollutants: sulfur dioxide, sodium chloride aerosol; nitrogen dioxide, unsaturated hydrocarbons; nitrogen dioxide, sulfur trioxide, ozone; nitrogen dioxide, unsaturated hydrocarbons, ozone; diglycidyl ether; diepoxybutane, and engine exhaust.

The epoxy compounds produced a significant degree of keratitis and iritis.

The epoxy compounds caused a characteristic sloughing of the epithelium and damage to the underlying stroma. The rate of regeneration of the epithelium and its dehydrogenase activity were unaffected. The other air pollutants used showed no observable effect on the entities studied. - Authors' Sum.

567. Mitchell, R.I.: Retention of aerosol particles in the respiratory tract . A Review, Am. Rev. Resp. Dis 82:627-639 (Nov.) 1960.

There is considerable disagreement among the various investigators as to particle retention in the lungs. The two major causes of lack of agreement are failure to use a uniform breathing rate and the use of a mean particle size to describe a test aerosol which has a wide size distribution. Both experimental and theoretical results show a minimum retention in a 04-0.6 μ range. All of the data also indicated 90% or more retention of particles greater than 7 μ. In addition to particle size, the next greatest variable affecting retention is breathing rate. The theoretical calculations of Landsahl agree well with the experimental results obtained by his coworkers, except for particles in the 2 μ range. For this size, the theoretical calculations give results that are too high at both breathing rates studied. The use of radioactive NaCl to obtain an approximation of alveolar retention gives an excellent means of measurement for retention in the smaller branches, bronchioles, and alveoli in therapeutic applications of aerosols. To establish definitely the particle size for maximal retention, the experiments should be repeated using a non-hygroscopic carrier. The results of glycerol-water aerosols indicate that the maximum occurs for particles which have an equivalent diameter of 1.5 μ. By assuming that the particles grow until they contain 85% water, the diameter for the maximum would increase only to 2.3 μ. APCA

568. Mitina, L.A.: The combined effect of small concentrations of nitrogen dioxide and sulfur dioxide gases. Gig. i Sanit. 27:3-8 (Oct.) 1962.

The combined effect of nitrogen dioxide and sulfur dioxide gases was studied in a chronic poisoning experiment, and the features of the effect produced were analyzed. It was determined that a mixture of NO_2 and SO_2, (with NO_2 in a concentration of 0.0057 mg./l. and of SO_2 in that of 0.01 mg./l.) caused a fall in the experimental animal's body weight, a change in the blood picture, and a decrease in the phagocytic activity of leukocytes. When the concentrations used were half as high, changes were noted in the white blood cells together with a fall in the phagoxytic activity of leukocytes. The latter was apparently caused by the toxicity of NO_2 in the concentrations used. The combined action of the 2 gases investigated revealed a certain antagonistic effect. - APCA

569. Morando, A.: Experimental and clinical contribution to human pathology due to sulfuric acid fumes. Med. lavoro 47:557-561 (Oct.) 1956.

Normal human subjects, not accustomed to inhaling sulfuric acid fumes, were made to inhale for 5-15 minutes air polluted with sulfuric acid concentrations from 0.35 up to 5 mg. per cu. m. Even at concentrations that are not subjectively detected by the persons under test, the respiratory flow rapidly increases and continues high until some minutes after the end of the test; the increase is more evident at higher concentrations. The increase in respiratory flow involves a reduction of the percentage of the acid retained in the respiratory system, and can be considered as a defense mechanism. Fifty-seven workers in the sulfuric acid production department were also followed up for several years; there was no evidence of a particular increase in the occurrence of bronchial or lung diseases, nor of conjunctival or pharyngeal irritation. Numerous cases of gastritis and gastro-duodenitis, gastric ulcers, and digestive troubles were observed. Chronic exposures to relatively low concentrations of sulfuric acid as those to which the workers under examination were exposed, seem to produce gastro-intestinal tract lesions more easily than respiratory system lesions. - English Sum.

570. Morrow, P.E., Some physical and physiological factors controlling the fate of inhaled substances. I. Deposition. Health Phys. (London) 2:366-378 (May) 1960.

There are a variety of experimental approaches to the measurement of dust deposition. The common requirement in all methods is the ability to measure some parameters of the air-borne dust before and after it is breathed. To make dust deposition quantitative so that toxicity or retention studies can be pursued, it is necessary to measure, in addition to the parameters mentioned, the amount of dusty air respired. This paper discusses various physical and physiological factors in terms of their effect on aerosol stability, as they are related to the deposition of dusts in the respiratory tract of man. Efforts are made to indicate the nature of the more important factors and the circumstances in which they might be most significant. 54 references. - APCA

571. Pattle, R.E.: Toxic effects with mixtures of sulfur dioxide and smoke with air. Chemical Defense Experimental Establishment (Gt. Britian), Porton Tech. Paper No. 525, AD 90-929, ASTIA Tab No. U-107:4 July 1956 and J. Petrol. Bacteriol. (London) 73:411-419 (April) 1957.

1. The "dosage up to death" (CtD) is defined as the dosage received by an animal continuously exposed to a toxic atmosphere up to the time at which it dies.
2. The "dosage to 50% deaths" (CtD50) is defined as the dosage which would be received by the survivors of a large batch of animals, continuously exposed to a toxic atmosphere, by the time 50% of the batch had died.
3. The toxicity of sulfur dioxide in a concentration of about 2,700 mg/m^3 (1,000 ppm) to mice is enhanced by the addition of 100 mg/m^3 of smoke from a kerosene lamp.
4. A similar effect probably exists with guinea-pigs.
5. Previous exposure to smoke has some protective effect against sulfur dioxide; the CtD50 for mice previously exposed to about 40 mg/m^3 of smoke for 22 hours was 56% higher than for fresh mice. The protection appears to involve a reduction in the amount of lung oedema produced.
6. Smoke which has been in contact with sulfur dioxide (5,100 mg/m^3, 1,900 ppm) and from whose gaseous environment the sulfur dioxide has been removed with alkali, had no effect on mice different from that of ordinary smoke. Neither caused fatalities when administered over 77 hours at an average concentration of about 50 mg/m^3 (Ct about 230,000 mg. min/m^3), and the histological pictures produced by the smoke were identical in the two experiments.
7. Relatively small differences in toxicity may give rise, in the early stages of an experiment, to apparently much greater differences in mortality. The bearing such a phenomenon would have on the lethality of atmospheric pollution is discussed. - Authors' Sum.

572. Pirila, V., Kajanne, H., and Salo, O.P.: Inhalation of sulfur dioxide as a cause of skin reaction resembling drug eruption. J. Occupat. Med. 5:443-445 (Sept.) 1963.

The authors discuss the primary irritant action of sulfur dioxide on the mucous membranes of the respiratory system and of the eyes. The gas also has a possible specific effect in asthma, and in some cases of fairly high concentrations may have an irritant effect on the skin. However, cutaneous reactions of allergic type due to SO_2 inhalation are almost unknown, the authors having reported only one previous case of urticaria. In this paper they report the case history of a patient who developed exanthema resembling drug eruption following exposure to SO_2. The significance of SO_2 as an air pollutant is discussed. - APCA

573. Renzetti, N.A. (editor): An Aerometric Survey of the Los Angeles Basin Aug.-Nov. 1954. Report No. 9. Los Angeles, Calif. Air Pollution Foundation, 1955, 333 pp.

Chapters: Need for Aerometric Survey - Facilities and Equipment (Description of Sampling Sites, Instrumentation, Supporting Meteorological Observations) - Operations (Schedule of Measurements at Sampling Stations, Observations Aloft) - Measurement of Eye Irritation (Development of Techniques for Quantifying Subjective Reactions) - Studies in Plant Response - Data Reduction Techniques - Interpretation of Results - The Nature of the Suspended Matter - Statistical Analysis of Aerometric Survey - Instrument Developments.

A comprehensive and coordinated survey of selected pollutants and principal smog effects was conducted at 10 stations during the 4 months of maximum smog probability, covering 24 separate projects; planned and supervised by the Foundation's scientific staff; substantially supported by the Los Angeles Air Pollution Control District - A $400,000 project in which 305 people participated for a total of 9000 man-days. New and important findings are reported here for the first time. Of equal value may be its systematic approach to the air pollution problem of a large metropolitan area. Improvements are suggested in conducting future surveys, whether in Los Angeles or elsewhere. - APCA

574. Salem, H., and Aviado, D.M.: Inhalation of sulfur dioxide. Comparative behavior of bronchiolar and pulmonary vascular smooth muscles. Arch. Environ. Health 2:656-662 (June) 1961.

The inhalation of 200 to 850 ppm sulfur dioxide caused the following effects in anesthetized dogs: (a) pulmonary vasoconstriction, (b) bronchoconstriction, preceded and followed by bronchodilation; (c) increase in pulmonary arterial blood pressure; (d) depression of myocardial force of contraction accompanied by brady-cardia; (e) systemic shock. The constriction of the pulmonary veins supplements the bronchiolar muscles and respiratory reflexes in reducing the amount of sulfur dioxide absorbed via the pulmonary circulation and carried to the systemic circulation. - Authors' Abst.

575. Sim, V.M., and Pattle, R.E.: Effect of possible smog irritants on human subjects. J.A.M.A. 165:1908-1913 (Dec. 14) 1957.

Various aerosols and gaseous mixtures were administered to adult male volunteer subjects by two methods, one using a mask, the other involving a chamber large enough for all subjects to occupy at the same time. The main effects of sulfur dioxide gas and sulfuric acid mist inhaled in this way were an increase in airway resistance and appearance of rales, with rhinorrhea and lacrimation. Two subjects exposed to sulfuric acid mist developed long-lasting bronchitic symptoms; the addition of water vapor increased the mean particle-size of the sulfuric acid mist and intensified its irritant effects. These acid substances were neutralized and their irritant effects abolished by adding either ammonia gas or magnesium oxide smoke to the atmosphere. While acrolein and crotonaldehyde were highly irritant, formaldehyde was less so; acetaldehyde and its higher homologues were almost nonirritant. It was evident that neither the concentration of sulfur dioxide nor the total aldehyde content of an atmosphere is an adequate index of its irritant action, especially on people handicapped by disease or old age. - Authors' Sum.

576. Toigo, A., Imarisio, J.J., Murmall, H., and Lepper, M.N.: Clearance of large carbon particles from the human tracheobronchial tree. Am. Rev. Resp. Dis. 87:487-492 (April) 1963.

A technique is described whereby carbon particles of known large size are labeled with a radioisotope (I^{131}) and delivered to the tracheobronchial tree of unanesthetized humans. The disappearance of labeled radioactivity from a field over the trachea and main stem bronchi was measured. It was demonstrated in preliminary observations that the clearance of carbon particles is faster in normal subjects than in subjects with chronic lung disease. The influence of cough upon clearance in both normal subjects and patients with chronic lung disease was observed. - Authors' Sum.

577. Whittenberger, J.L., and Frank, R.N.: Human exposures to sulfur dioxide. Arch. Environ. Health 7:244-245 (Aug.) 1963.

The principal measurements made were those of resistance of the airways, total lungs, or the total lungs plus thorax. The esophageal pressure was normally used as an index of pressure changes in the thorax, and the vol. displacement plethysmograph was used for recording the vol. and flow. The esophageal catheter method combined with the vol. displacement plethysmograph had a higher variance than the other methods, but it was most sensitive to the effects of SO_2 which occurred during the course of the measurement. The measurements were made during the control period, while the subject was breathing SO_2, and during 10 min. of recovery. The level of SO_2 varied around an average of 1, 5, and 13 ppm. The use of a flowmeter indicated a change in about 90% of the instances in which there was an increase in resistance. The 1-sec. forced expiratory vol. was less consistent in showing responses in SO_2. - APCA

578. Wright, G.W. and Lloyd, T.: The pulmonary reaction of normal and emphysematous persons to the inhalation of SO_2, fly ash, and moisture. Syllabus for the Third Air Poll. Res. Seminar. New Orleans, La., March 22-24, 1960, p. 27.

Eight normal men and four persons having diffuse obstructive emphysema comprised the study group. The subject sat for 20 to 25 minutes in a chamber for each exposure. SO_2 concentrations were 2.5, 5.5, 10, and 23 ppm. Particulates less than 10 microns in size varied from 6 to 1.2 million particles per cubic foot. No measurements of water particles were made, water aerosol simply being added to the ambient air when desired. The following measurements were made before and as soon as possible after the gas exposures: Airway resistance (Plethysmograph), maximum and maximum mid-expiratory flow rates, maximum breathing capacity, times vital capacity, pulmonary volumina (closed circut nitrogen), ventilation effectiveness (closed circuit nitrogen) were measured before and within 20 minutes after exposure. The normal subject showed no trend as to resistance changes consequent to exposure. One individual consistently demonstrated an increase, and another a decrease after each exposure. None of the variations followed the exposure were greater than hour to hour or day to day variations of control non-exposed persons. No systematic fluctuations related to any of the various combinations of exposures were observed in the other measurements made in the eight normal persons. Four men having classical clinical and physiologic evidences of diffuse obstructive emphysema were exposed for 20 minutes to 5 ppm. SO_2, 6.0 mpcf. and added water aerosol. The maximum breathing capacities of these four men were as follows: 56,32,28, and 20 liters per minute. Each individual demonstrated a decrease in the airway resistance, and no change in the other measurements following the exposure. - Authors' Abst.

579. Yokoyama, E.: Effects of acute exposure to sulfur dioxide on the mechanics of breathing in healthy men. Bull. Inst. Pub. Health (Tokyo) 12:22-28 (March) 1964.

An experiment was made to confirm (1) what effect an acute exposure (single or repeated) to sulfur dioxide might have on the mechanics of breathing in healthy men, and (2) whether spirometric and peak-flow-rate tests are able to detect the effect of sulfur dioxide on the mechanics of breathing, if such effects had occurred. Fifteen healthy adult male volunteers were exposed to sulfur dioxide at a concentration of 15 to 30 ppm. Measurement of the mechanics of breathing was made with an intraesophageal pressure technique. Exposure lasted for 10-15 minutes. Flow resistance and ventilatory work were elevated for 15 minutes thereafter, except inspiratory resistance. There were no consistent changes in lung compliance and respiratory rate, but tidal volume increased. It is shown from these results that sulfur dioxide acts to increase the flow resistance in the lung even in healthy men. Spirometric and peak-flow-rate tests done at the end of the exposure, however, showed no significant change. Three repeated exposures at 1-hour intervals were made in 4 subjects. Although the difference between the change in mechanics in each exposure was not statistically significant, there was some suggestion that an adaptation to sulfur dioxide, and also a superimposition of stress, might be possible. - APCA

7. INDUSTRIAL EXPOSURES

580. Anderson, A.: Possible long term effects of exposure to sulfur dioxide. British J. Indust. Med. 7:82-86, 1950.

Workers exposed to daily concentrations of sulfur dioxide for periods of time varying from 1 to 19 years were examined. Special attention was paid to age, weight, blood pressure, vital capacity, and radiography of the chest. The daily concentration of sulfur dioxide varied between 0 and 25 ppm. Occasionally, figures of 100 ppm were recorded. Workers not exposed to sulfur dioxide but otherwise subject to similar working conditions were also examined, special attention being paid to the same details of examination. No evidence of adverse effects on health could be found. - Author's Sum.

581. Anonymous: Effects of the various refrigerants (including sulfur dioxide) upon the human body. Refrig. Eng. 9:141, 1922.

Because of the marked irritating effect of sulfur dioxide on the eyes and throat, the resulting desire to get fresh air is considered by the author to decrease the possibility of harm from this gas. Those exposed to 5 to 20 parts per million are so uncomfortable that they are compelled to leave the area of concentrations. However, small amounts of sulfur dioxide may cause coughing, and those unaccustomed to it cannot tolerate it. Those who are exposed to it in their daily work establish a gradual tolerance and take no notice whatsoever of an atmosphere in which it is present to such an extent that persons unaccustomed to it cannot breathe it. - BAAP

582. Clinton, M.: Sulfur Dioxide. Am. Petroleum Inst. Rev. (Sept.) 1948, 5 pp.

This review summarizes the best available information on the properties, characteristics, and toxicology of sulfur dioxide. It offers suggestions and tentative recommendations pertaining to medical treatments, medical examinations, and precautionary measures for workers who are exposed to sulfur dioxide. It was prepared at the Harvard School of Public Health, Boston, Mass., under the direction of Professor Philip Drinker.

583. DeMichelis, F.: Stomatology of workers exposed to, or affected by, occupational poisoning. V. Nitric, sulfuric, and hydrocyanide acids, hydrogen sulfide, calcium cyanamid, benzene, and its homologs. Med. Y Seguridad Trabajo 3:49-55, 1955.

The alterations found on examining the teething system of laborers exposed to an intoxication by: nitric acid and nitrous oxyd, sulfuric acid and sulfhydric acid, cyanhydric acid and compounds of cyanogen, calcic cyananide, benzol and similar substances are exposed. In all these groups to facilitate the study, the system of dividing the examined persons into two parts is employed, one of them formed by the laborers with a working age of 1-3 years and the other by those possessing an age superior than 3 years. The effect of the different toxic substances on the teeth and surrounding parts is examined and rules are established for impeding as far as possible this destructive action. - English Sum.

584. Dowling, H.F.: Asthma following prolonged exposure to sulfur dioxide. Report of a case. M. Ann. District of Columbia 6:299-300, 1937.

A case is reported in which symptoms of asthma developed in a person with an allergic constitution after repeated and prolonged exposures to inhalation of sulfur dioxide. According to the best evidence available, the inhalation of sulfur dioxide over a long period of time causes no permanent damage to experimental animals or normal human beings. Persons with an allergic history or background should not be exposed to sulfur dioxide over any considerable period of time. - Author's Sum.

585. DuBois, A.B.: Industrial bronchitis and the function of the lungs. Arch. Environ. Health 4:128-131 (Feb.) 1962.

Eleven patients who had histories of acute or chronic exposure to irritant materials in the inspired air were studied radiographically and by means of pulmonary-function tests. Objective evidence of lower airway obstruction was found even when the x-ray of the lungs showed little or no change. The symptoms of exertional dyspnea appear to have been attributable to the presence of increased airway resistance and impaired ventilation of portions of the lung. - Author's Abst.

586. Fieldner, A.C., Katz, S.H., and Kinney, S.P.: Poisonous gases encountered by Firemen. USBMTP 248, 1921.

Smoke is extremely irritating to the eyes and throat and may interfere with breathing sufficiently to produce unconsciousness. When inhalation of sulfur dioxide is prolonged, or the concentration is very high, death may result from respiratory spasms and asphyxia. "Ordinarily, however, exposure to mild fumes merely produces headache, coughing, smarting of the eyes, and later constriction of the chest and bronchitis." The effects of other gases, such as carbon dioxide, carbon monoxide, ammonia, illuminating gas, and chlorine, are also discussed. - BAAP

587. Flury, F.: Is pernicious anemia caused by the inhalation of sulfur dioxide? Führer-Wieland's Samml. Vergiftungsfällen 2:15-26, 1931.

The possible connection between the inhalation of SO_2 and the subsequent occurrence of pernicious anemia (p.a.) was investigated on the basis of the observations made in one clinical case. The patient had been a 59 yr. old man in good physical condition, who had worked in a mill for the past 33 yr. There was no anamnestic evidence of a predisposition for p.a. In July 1928, he fumigated the mill against meal moths with SO_2 using 5 kg. of S, as he had repeatedly done before. The next day, he suddenly felt severely ill and rested for 3 hr. in a room next to the mill, with the door to the mill open. He continued to work until he had a sudden aggravation of his condition in Jan. 1929. Then he was hospitalized, with the diagnosis of p.a., for 3 mo., discharged without any improvement and died in Oct. 1929. No autopsy was done. The following symptoms were observed: collapse during the examination on the 3rd day after the fumigation of the mill, acute irritation of the pharynx and conjunctivae, severe headache, severe gastrointestinal disturbances, anorexia, insomnia, weight loss (27.5 kg. within 9 mo.), severe blood changes, striking paleness of skin and mucosae. The following blood values are given as results of blood tests carried out 9 mo. after the exposure: Hb - 30, erythrocytes - 1.4 millions. On the basis of clinical experience and animal experiments, the author discusses further effects, apart from those observed in the described case, that had been attributed to the inhalation of SO_2, e.g., effects on the central nervous system, on the blood or on the hematopoietic organs. Various modifying factors, such as differences in individual resistance as well as adaptation to continued exposure are mentioned. It is pointed out that there are very few reports on fatal SO_2 poisonings in humans, probably due to the highly irritating properties of the gas. There is, however, not one known case, where a clinical picture such as the one described, was attributed to the action of irritant gases, particularly to SO_2. Some information of the nature of p.a. per se as well as following poisoning is presented, and the possible connection between exposure and subsequent death is discussed. In the conclusion, it is said that, as is true for most cases of poisoning, there are several unknown factors, e.g., the exact amount of SO_2 inhaled could not be determined, nor is there positive evidence proving that no p.a. had been present at the time of the exposure. Also, the nature of the disease is not yet fully known. Thus, it is not possible to state definitely whether or not the p.a. in question was entirely due to the inhalation of SO_2. At any rate, it was considered one of the essential causes for the death of the patient. - KB

588. Goldman, A., and Hill, W.T.: Chronic bronchopulmonary disease due to inhalation of sulfuric acid fumes. A.M.A. Arch. Indust. Hyg. & Occupat. Med. 8:205-211 (Sept.) 1953.

A 40-year-old white man, previously healthy, was accidentally exposed to liquid oleum (fuming sulfuric acid) and for eight minutes to sulfuric acid mist and fumes from the action of water on oleum. He was severely burned about the face and body. Respiratory difficulty developed immediately, requiring 10 days of oxygen therapy and six weeks of hospitalization. Eighteen months later the patient had a disabling pulmonary fibrosis, residual bronchiectasis, and pulmonary emphysema.

In view of the experimental work on animals, this case suggests the following sequence of events. The immediate effect of the fumes was edema of the larynx and tracheobronchial tree and probably pulmonary edema. Partial atelectasis of the left lower lobe occurred early. Large amounts of white, frothy, and hemmorhagic sputum were present early in the disease, denoting necrosis and micinous degeneration of the bronchial epithelium. Secondary infection occurred, and multilobe bronchiectasis developed, which was most marked in the left lower lobe. As a resultant there was an interstitial fibrosis and pulmonary emphysema. It appears likely that these changes in the bronchopulmonary tract are permanent, because they persisted for 18 months. The lesions described in this patient are similar to the changes occurring in guinea pigs exposed to sublethal doses of sulfuric acid mist. It is unlikely that chronic changes will often result in humans, for sulfuric acid fumes are so irritating that workers cannot remain in such an atmosphere. - Author's Sum.

589. Guarino, A., Biondi, S., Verde, G., and Simone, F.: The sulfur mine combine at Altavilla Irpina. Folia Medica 44:941-970 (Nov.) 1961.

The sulfur-mine combine at Altavilla Irpina is described from the geological and technological point of view, and the results of environment and industrial health studies dealing with microclimate, dust and the presence of poisonous gases are reported. In particular, it was found that microclimate was considerably unhealthy in some of the working places, especially in these at lowest levels, owing to high temperature and dampness dust levels were found to be high in perforation and millsulfur deposit sectors: poisonous gases were generally not found to be present to an alarming extent and their presence was however found to be limited to well defined periods in the working day. Individual and environmental preventive measures are suggested. - APCA

590. Heyrovsky, J.: Oscillographic determination of oxygen and some noxious gases in the atmosphere of workrooms. Anal. Chim. Acta 8:283-294, 1953.

The cathode ray oscilloscope has been adapted for rapid qualitative analysis with the dropping or streaming mercury electrode. Provision is made so that the oscilloscope shows the potential-time curves as well as the derivative-potential curves. The potentials of cations which give distinct time-lags have been computed. Numerous organic depolarizers such as aldehyde, unsaturated compounds, nitro-compounds and quinones may be similarly determined. The method is of advantage where quick qualitative and approximative quantitative analysis of samples is concerned, e.g. in ore analysis, or especially in organic analysis for testing the purity of preparations and distinguishing isomers. Decomposition of fresh aqueous solutions of penicillin may be followed by this method of oscillographic analysis. In addition, there are several other applications of the method, e.g. rapid qualitative analysis of carbon disulfide, hydrogen sulfide, hydrocyanic acid and sulfur dioxide in the atmosphere of industrial works. - Author's Sum.

591. Industrial air pollution. Chem. Age (London) 73:995-997 (Nov. 5) 1955.

Among the 531 visits made by the Alkali Inspectors to industrial activities not registrable under the Alkali Act have been several to electrical generating stations. At one power station complaints were made relating to grit and dust deposition. The de-dusting facilities were found to be unsatisfactory and a complete overhaul has been undertaken. Visits were made to the Battersea and Bankside power stations for the purpose of assessing the extent and efficiency of gas washing as practiced there for the removal of sulfur oxides from the boiler gases. Production of sulfuric acid in 1954 was 1,838,000 tons, of which about half a million tons were made by the chamber process. The use of pyrites has trebled over the past 4 years. - APCA

592. Isaev, N.S.: Poisoning due to nitrogen oxides and sulfur dioxide. Voenno-Med. Zhur. 4:252-61, 1933.

During the production of H_2SO_4 by the chamber process, both N oxides and SO_2 are given off. In the U.S.S.R., the MAC's are established at: 0.005 mg. N oxides and 0.04 mg. SO_2/l. air. The investigation reported here revealed that in the plants examined, the concentration of these gases varied considerably and often by far surpassed the MAC's: for N oxides by 5-305 times, for SO_2 by 1½ times. The information on the typical clinical picture demonstrated following inhalation of both gases is illustrated by case reports.

The inhalation of both gases produces cough, productive in case of N oxides, more severe and dry in case of SO_2. N oxides may cause pulmonary edema. Following exposure to both, there is fresh blood in the sputum, nausea, vomiting, dyspnea and a feeling of oppression in the chest. Relatively rare are headache and vertigo, while respiration and pulse rates frequently are high: respiration - up to 26/min. in the absence of pulmonary edema, 35/min. with edema; pulse-78/min. without edema, 120/min. with edema. The latter symptoms are accompanied by an increase in body temperature and changes in the lungs. The body temperatures are subfebrile, when only irritations of the respiratory tract are caused, while action on the lung is demonstrated by a rise in temperature of up to 40° C. Within 24-48 hr. after exposure, the reaction of the lung tissue starts immediately upon penetration of the gases into the lungs. Cardiovascular disorders are observed only in cases of advanced edema. No changes in the blood Hb were found.

SO_2 poisoning was studied in 11 patients. The clinical signs included irritation of the upper respiratory tract and degenerative changes in trachea and bronchi, due to surface oxidation of SO_2 to SO_3, subsequent combination with H_2O vapors and absorption by the mucous membranes under formation of H_2SO_4, as well as myocardiac changes.

The action of N oxides (NO, N_2O, N_2O_4) is described as follows: at high concentrations, they have the effects of a mild anesthetic. On the whole, they affect the lungs much more than the upper respiratory tract. In the latter and in the bronchi, inhaled N oxides become HNO_3 which causes reactions in the pulmonary tissue. The salts formed ($NaNO_2$, $NaNO_3$), absorbed by the blood lower the blood pressure by causing dilatation of the blood vessels. General effects of the nitrites on the organism were seen in only 18% of the cases; much more pronounced was the action of the N oxides on the pulmonary tissue. Poisoning due to N oxides was studied in 27 patients, 16 of whom had pulmonary edema, appearing 8-10 hr. after exposure. The author discusses various phases of pulmonary tissue reaction, complications in cases of pulmonary edema and various aspects of therapy.

Hygienic control measures are recommended. - KB

593. Laskin, S., Turner, R.A., and Stokinger, H.E.: Analysis of Dust and Fume Hazards in a Beryllium Plant. U.S. Atomic Energy Comm. Doc. MDDC - 1355, Decl. (Sept. 25) 1947.

In a Be-producing plant, investigated because of frequent occurrence of Be-poisoning, the following major potential hazards were present: Be ore dusts, BeO, BeCu acid mists and fumes ($BeSO_4$), Pb and Cu sulfides, SO_3, acid fluoride, $(NH_4)_2BeF_4$, BeF_2HF, NH_4F dusts and fumes and Be metal. Selected areas of atmospheric contamination associated with the processes involved were sampled, the selection being based on past medical history of hazard or on obvious contamination at the time of the survey. Sites selected were the ore-treatment area and that about the BeF_2 and Be metal furnaces. Of the 3 areas surveyed, those of the BeF_2 and Be metal furnaces showed the most hazardous concentrations of Be and F. The F concentration near the F furnace was disproportionately high, possibly representing a hazard in itself. The concentration of Be 3 ft. from the furnace opening during the pouring operation was ca. 0.065 mg./m.^{3}. During the pouring operation of the Be metal furnace, Be concentrations varied from 1.4 to 4.7 mg./m.^{3} at approximately 3 ft. from the furnace. Samples for F in this site were of the order of 1.7 mg./m.^{3}. Near the rotary kiln drier for Be ore treatment, Be dust concentration varied from 0.050 to 0.53 mg./m.^{3}. F concentrations in the air were of the same order of magnitude. A particle-size analysis of the air contamination samples by the means of the cascade impactor showed a mass median particle size of 0.86μ in the vicinity of the Be metal furnace, 2.46μ next to the BeF_2 furnace, but sizes of up to 10μ in the area about the ore treatment room. Another problem investigated was that of beryl ores suspected of containing radioactive impurities. One of 3 suspected ores showed significant activity equivalent to 12.6% U, which on spectrochemical analysis later revealed 4% U, 0.4% Th and 0.4% Pb. This degree of activity represents a definite Tn or Rn hazard and suggests the possibility that U or other radioactive materials may act synergistically or as predisposing agents in Be poisoning. During the period 1943-6, 136 cases of Be poisoning were observed, most of which involved conditions of the skin (50%) and the respiratory tract. The latter were attributed to all exposures present, while dermatologic symptoms resulted from exposure to $BeSO_4$ and BeO, Be fluorides and SO_3. The affected workers ranged in age from 20 to 50 yr. 117 of them were male, 19 female. The onset of the acute respiratory symptoms was observed 1-4 mo. after the first exposure, occasionally even after 3-10 da.; the dermatologic conditions appeared after 7-10, occasionally after 2 da. The dermatitis, affecting exposed areas of the skin, was often severe, being of the edematous, papulovesicular type. When the face was involved, there was invariably associated conjunctivitis. An element of sensitivity was believed demonstrated. It was not uncommon to find individuals showing both dermatitis and bronchitis, especially if permitted to continue work in the areas of the sulfating process and F furnace. Chemical pneumonitis presented the severest type of Be poisoning and occurred among workers without respect to type of process. Several deaths from this cause were reported in 1943. Typical symptoms were cough, substernal pain, shortness of breath, cyanosis, anorexia, weight loss and increasing fatigue. The vital capacity was reduced. There was a low-grade fever. Recovery did not occur if work was continued. Examination of lung tissue sections showed a large number of plasma cells, diffuse pulmonary edema and hemorrhage. X-rays of the lungs were diagnostic. Prior to 1943, the plant had experienced relatively little trouble, but increase in intensity of operations with the outbreak of war, together with loss of trained and selected personnel by the operation of the draft, may be listed as possible factors responsible for an epidemic effect.

The general plant history showed a shift in the number of cases through the years 1943 to 1946. During 1943-4, the sulfate and Be-Cu processes were particularly involved. Following improved conditions at this site, the production emphasis shifted to BeF_2 and Be metal where, at the time of investigation, the greatest proportion of cases appears (1946). The number of cases ranged from 63.5 to 238.1/million man-hr. of exposure, whereas the acceptable number in well-established chemical industries is 4.- KB

594. Leong, K.J., MacFarland, H.N. and Sellers, E.A.: Acute sulfur dioxide toxicity. Arch. Environ. Health 3:668-675 (Dec.) 1961.

A comparison has been made of the susceptibilities of normal and pretreated mice, rats and guinea pigs to a single lethal inhalation exposure to sulfur dioxide. For each species, tests were conducted at 3 different concentrations of the gas. The mean survival time of exposed groups was employed as the criterion of response. When mice and rats were pretreated by the intraperitoneal injection of 200 or 300 mg. per kilogram of histamine, mean survival times were significantly reduced when compared with the values obtained for normal animals at all sulfur dioxide concentrations examined. The tolerance of adrenalectomized rats were found to be more susceptible to high sulfur dioxide concentrations than normal animals. Histological examination of the lungs of animals from the various groups revealed that the severity of the damage was primarily dependent on the length of exposure. In normal animals, pulmonary edema with areas of consolidation were usually observed. In the case of those treatments which produced a significant reduction in survival time, the animals generally exhibited bronchial obstruction. The relationship of these results to the problem of sensitive individuals who exhibit acute responses to urban smogs has been discussed. - Author's Sum.

595. Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U.S. Department of Commerce, Office of Technical Services, Washington, D.C., vol. 1, Jan. 1960.

This 1st vol. in a series of survey reports of the general U.S.S.R. literature directly or indirectly related to air pollution, where, in general, the research was done outside the jurisdiction of Ryazanov's Comm. on Limits of Allowable Concentrations of Community Air Pollutants, which was later given the official designation of the Comm. of the Chief State Sanitary Inspection of the U.S.S.R. (see items 3091-4). Vol. 1 contains 38 condensed translations and supplements of this Russian literature grouped in 3 sections: (1) general information, (2) studies of toxicity and its effect on health and general living conditions, and (3) analytical findings. Each item included in the collection is headed by the original title in translation, the name of the author or authors, institutional affiliation, and periodical or book from which the item was selected. The vol., issue number, yr. of publication, and inclusive pages of the reference are indicated to make it possible to locate the Russian original. - APCA

596. Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U. S. Department of Commerce, Office of Technical Services, Washington, D.C., vol. 2, March 1960.

This 2nd vol. in a series of survey reports of the general U.S.S.R. literature directly or indirectly related to air pollution, contains 43 translations of this Russian literature grouped in 3 sections: (1) methods and procedures, (2) carcinogenesis, radiation, and air pollution, and (3) toxicity, effect on health and general living conditions as in Vol. I. Each item included in the collection is headed by the translation of the original title, the name of the author or authors, institutional affiliations, and the name of the periodical or book from which the item was selected. This latter citation includes also the vol. and issue number, yr. of publication, and inclusive pages in order to make it possible to locate the Russian original. In the introduction to the vol. is a statement that the limits of allowable open, or atmospheric, air pollution for inhabited localities were originally accepted as one third of the limits previously adopted for factory air for the corresponding pollutants. As research progressed and rational data were accumulated, these arbitrary standards were amended or replaced. An appendix gives a tabulation of the currently accepted concentration of 30 pollutants under the heading of Maximum Allowable Concentrations of an Air Pollutant to Be Used for Hygienic Evaluation of the Air in Populated Areas. - APCA

597. Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U.S. Department of Commerce, Office of Technical Services, Washington, D.C., vol. 3, May 1960.

This 3rd vol. in the series of survey reports of the general U.S.S.R literature, directly or indirectly related to air pollution, contains 52 translations from Russian literature. The foreword of the vol. lists the various Russian journals and the yr. of their publication from which the material was selected; each individual item within the vol. gives a full reference to the specific journal. The 52 items are grouped under the following sections: (1) analytical methods and procedures, (2) evaluations and comparative studies, (3) hygienic standardization (limits of allowable concentrations), (4) sampling and other apparatus, (5) air pollutants, (6) toxicology and pharmacology, (7) microbiology, (8) conferences, and (9) miscellaneous. - APCA

598. Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U.S. Department of Commerce, Office of Technical Services, Washington, D.C., vol. 4, Aug. 1960.

Sec. 1. Methods and determinations analytical. 2. Apparatus, devices and equipment. 3. Absorption of gaseous pollutants. 4. Poisoning, acute,chronic, and other. 5. Hygienic evaluation and limits of air pollutants. 6. Sanitary clearance zones. 7. Effect of meteorological conditions, ventilation. 8. Bacterial substances emitted by living plants (phytoncides). 9. Dustiness investigation. 10. Fuel and gas combustion studies. 11. Street noise abatement. 12. Administrative and semipopular. This 4th vol. in the series of survey reports of the general U.S.S.R. literature, directly or indirectly related to air pollution, follows closely the format established in the earlier vol. The 53 translations, mostly from scientific journals, and a final compendium of official materials related to problems of sanitation and prophylaxis. - APCA

599. Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U.S. Department of Commerce, Office of Technical Services, Washington, D.C., vol. 5, Jan. 1961.

Sec. 1. Hygienic evaluation. Limits of allowable concentration. 2. Pharmacological, toxicological, clinical. 3. Sanitization. 4. Ionization and ultraviolet radiation. 5. 3,4-Benzpyrene. 6. Analytical. The organization of the material in this vol. follows the same plan as in vol. 3 and 4. It is based on the principle and concept in conducting the survey of U.S.S.R. literature on environmental, in this instance atmospheric and indoor, air pollution and means of its sanitization. According to this concept, an environmental, atmospheric or indoor air pollutant is any agent or factor which, if present in the environment above certain quantitative levels, elicits unfavorable temporary or permanent shifts in the organisms' functions which might interfere with its normal activities, general well being, or feeling of discomfort. - APCA

600. Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U.S. Department of Commerce, Office of Technical Services, Washington, D.C., vol. 6, April 1961.

The general plan of Vol. 6 is the same as the plan of any of the preceding vol. of this survey of the U.S.S.R. literature directly or indirectly related to air pollution. The table of contents, which was supplemented by the names of the journals in which the original articles appeared, is assembled under the following

Sections: I. Experimental studies in air and gas purification of gaseous and dust pollutants by adsorption and absorption methods. II. Sanitary clearance zone studies. Regulations pertaining to location (site), planning and construction of industrial production and processing plants. New classification of industrial clearance zones. Medical examinations of industrial workers and their fitness to engage in certain industrial occupations. III. Effect of environmental industrial conditions on immunity and other physiological processes. Experimental studies. IV. Studies in analytical procedures. V. Miscellaneous. VI. General and didactic papers. VII. A conference report. There is also an appendix which research students, who are interested in the application of Pavlovian perception physiology to certain phases of air pollution investigations such as limits of allowable pollutant concentrations, may find of special interest. A new classification of industrial sanitary clearance zones appears beginning with page 117 of this vol. This clearance zone classification replaces the 1 which was presented in Vol. 4, beginning with page 165. The new classification contains many important changes. The 2000 m. wide zones have been abolished, the 1000 m. sanitary clearance zones becoming the widest; widths of other sanitary zones have been reduced in various ways. In addition, certain types of manufacturing and processing industrial plants have been taken out of their old groupings and placed in other groups. A list of appropriate tables for conversion of metric measurements into the customary American and English equivalents, is given. - APCA

601. Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U.S. Depart. of Commerce, Office of Technical Services, Washington, D.C., vol. 7, April 1962.

The general plan of Vol. 7 is the same as the plan of any of the preceding vols. of this survey of the U.S.S.R. literature directly or indirectly related to air pollution. As with the 2 vols. which precede this 1 emphasis is given to what might be designated as theoretical work of an engineering character. The table of contents groups the articles in Sec. A through F but does not give the sections a subject heading. In the introduction by V. G. MacKenzie, Chief of the Div. of Air Pollution, U.S. P.H.S., he mentions that among the 60 papers which are translated in this vol. is 1 on the "Carboxyhemoglobin in the Blood of Persons Directing City Traffic" (290-93) in which the levels of blood COHb are the highest (12-40%) which have come to their attention. Another paper on "City Street Air Pollution by Autotransport Using Ethylated Gasoline" concludes with the drastic recommendation that "the use of ethyl lead gasoline be discontinued." The introduction concludes with a recommendation that consideration and evaluation of this information be given by all concerned for possible application to their respective fields of interest. - APCA

602. Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U.S. Department of Commerce, Office of Technical Services, Washington, D.C., vol. 8, 1963.

In this volume are incorporated official methods for the determination of deleterious substances in the air of working premises for sanitary control purposes, selections from a collection of studies on problems in the hygiene of atmospheric air conducted at the Leningrad Institute of Radiation Hygiene; selected papers from "Uchenye Zapiski" (Scientific Records) No. 6, dealing with hygienic problems of planning, building, and protecting the atmospheric air of new settlements; six selected papers from Gigiena i Sanitariya, the official U.S.S.R. sanitary-hygienic journal (1960-61); lists of officially approved limits of allowable atmospheric air pollutants; and regulations controlling noises in communal living quarters. The lists were brought from the U.S.S.R. by Mr. Vernon G. MacKenzie, Chief of the Division of Air Pollution, U.S. Public Health Service, and made available for translation and incorporation into this volume.

Unlike the plan of the preceding seven survey volumes, the material incorporated in the volume is grouped according to the sources from which the papers were selected rather than according to the nature of the subject matter they contain. For this reason the present volume is organized in five parts instead of in sections. - APCA

603. McCallan, S.E.A., and Setterstrom, C.: Toxicity of ammonia, chlorine, hydrogen cyanide, hydrogen sulfide and sulfur dioxide gases. I. General methods and correlations. Contrib. Boyce Thompson Inst. 11:325-330, 1940.

A series of cooperative tests were conducted in which a survey was made of the relative toxicity of five common industrial gases to various forms of plant and animal life. The apparatus employed permitted a continuous flow of the gas at definite concentrations. It is believed that this is the first survey attempted under such conditions.

The gases studied - ammonia, chlorine, hydrogen cyanide, hydrogen sulfide, and sulfur dioxide - were selected because of their chemical properties, physiological action, and their occurrence in industrial atmospheres. The organisms were chosen to give a wide range of behavior in the hope that a broader picture of the mechanism of toxic action might result. A total of 18 different species were studied, including plant and animal pathogenic fungi and bacteria, green plants, seeds, insects, and rodents. In some cases a given species was studied under different conditions,or in different forms or organs.

This first paper of the series describes the general methods employed and presents a summary correlation of the results on all organisms. Succeeding papers describe the original data in detail for the various organisms as follows: II. Fungi and bacteria (McCallan, S.E.A., and Weedon, F.R., ibid, pp. 331-342), III. Green plants (Thornton, N.C., and Setterstrom, C., ibid. pp. 343-356), IV. Seeds (Barton, L.V., ibid. pp. 357-363) and V. Animals (Weedon, F.R., Hartzel, A. and Setterstrom, C., ibid. pp. 365-386).

604. McClurkin, T.: Physiological effects of toxic gases and vapours. J. Inst. Petroleum (Univ. of Birmingham, England) 25:382-391, 1939.

In the first part of this paper the physiological effects of gases and vapours which are likely to be met with in the petroleum industry are considered. The second part deals with a group of other toxic gases and vapours. The list of gases and vapours covered by the two parts includes all those dealt with in Dr. Vallender's lecture on "The detection of toxic gases and vapours in industry" (J. Inst. Petroleum 25:392-409, 1939).

Throughout the paper the effects of exposure to various concentrations of gases and vapours are stated; they are from those given by Henderson and Haggard ("Noxious Gases" New York, 1927). At the end of the paper is given a list of works which have been consulted. Summaries of the literature on the toxicity of petroleum spirit, benzine, acetone, benzene, and the chlorinated hydrocarbons are to be found in the monograph by Browning (Medical Research Council, Industrial Health Research Board, Rep. 80, London, 1937). - Author's Abst.

605. Milby, T.H.: Hydrogen sulfide intoxication. Review of the literature and report of an unusual accident resulting in two cases of non-fatal poisoning. J. Occupat. Med. 4:431-437 (Aug.) 1962.

Hydrogen sulfide gas is a by-product of many industrial processes. Its characteristic odor is well known, but its toxic potentialities are not. It can be as undetectable by our senses as carbon monoxide and as rapidly fatal as hydrogen cyanide. In low concentrations it is an irritant to the eyes and to the membranes of the respiratory tract. Because of this latter effect, it may cause pulmonary edema. In higher concentrations, H_2S exerts a direct effect on the respiratory center.

This effect may be either one of stimulation with resulting hyperventilation, hypocapnia, and apnea or one of marked depression and paralysis. Respiratory failure and asphysia result in either case. Prevention of H_2S poisoning can be accomplished by educating personnel regarding the hazard, by controlling the environment, and by adequate medical evaluation of potentially exposed workers. Because there is no specific therapy for H_2S intoxication, treatment is aimed at relieving the signs and symptoms which develop. Two cases of nonfatal systemic H_2S poisoning are discussed. There is a bibliography of 25 references. - APCA

606. Monferdini, J.A., and McBride, F.T., Jr.: An industrial hydrogen sulfide air pollution control and monitoring program. Indust. Eng. Chem. 51:89A-90A (Dec.) 1959.

The decision to operate a sulfur mine in a locality of existing hydrogen sulfide sources and a residential area required control over all possible hydrogen sulfide emissions. A program was planned which would bring both the existing and proposed sources of hydrogen sulfide under the control of the mining company. Included also in the program was an atmospheric monitoring system within the residential area for hydrogen sulfide.

The various control measures applied to reduce the escape of hydrogen sulfide from the mining operations as well as from the other sources are briefly discussed and the results of the monitoring program have shown a decrease in atmospheric hydrogen sulfide. Diagram. - PHEA

607. Morando, A.: Experimental and clinical contribution to human pathology due to sulfuric acid fumes. Med. lavoro 47:557-561 (Oct.) 1956.

Normal human subjects, not accustomed to inhaling sulfuric acid fumes, were made to inhale for 5-15 minutes air polluted with sulfuric acid concentrations from 0.35 up to 5 mg. per cu. m. Even at concentrations that are not subjectively detected by the persons under test, the respiratory flow rapidly increases and continues high until some minutes after the end of the test; the increase is more evident at higher concentrations. The increase in respiratory flow involves a reduction of the percentage of the acid retained in the respiratory system, and can be considered as a defense mechanism. Fifty-seven workers in the sulfuric acid production department were also followed up for several years; there was no evidence of a particular increase in the occurrence of bronchial or lung diseases, nor of conjunctival or pharyngeal irritation. Numerous cases of gastritis and gastro-duodenitis, gastric ulcers, and digestive troubles were observed. Chronic exposures to relatively low concentrations of sulfuric acid as those to which the workers under examination were exposed, seem to produce gastro-intestinal tract lesions more easily than respiratory system lesions. - English Sum.

608. Nikulina, M.M., Hetmann, A. and Morgalina, N. M.: Morphologic and biochemical changes in the blood in acute sulfur dioxide poisoning. Leningrad Inst. for Investig. Indust. Dis. 8:89, 1934. Abstr. J. Indust. Hyg. & Toxicol. 17:52, May 1935.

The morphology of the blood is not changed in sulfur dioxide poisoning, but there is an increase of acid and of sugar in the blood, and this acidosis may be the chief cause of death. Administration of soda lessens the severity of the symptoms in animals and prolongs life. - BAAP

609. Ronzani, E.: Influence of the inhalation of irritant industrial gases on the resistance of the organism to infectious diseases. I. Chlorine, sulfurous acid, nitrogen tetroxide. Arch. Hyg. 67:287-366, 1908.

This is the first part of an extensive report of experiments carried out to establish the maximum concentrations of gases that can be inhaled by animals for a prolonged period of time without affecting their resistance to infection. Groups of rabbits, guinea pigs and pigeons were exposed 6 hr./day for periods of up to 1 mo., to inhalation of various concentrations given as one thousandth in the original of Cl, SO_2 and N_2O_4 in the air. One control group was provided for each experimental group. The effect of the exposure on the following phenomena was then examined: 1) the production of agglutinating substances, 2) the immunizing power of the blood serum, 3) the bactericidal power of the lungs, 4) the reaction of the susceptive animals to inoculation of both virulent and 5) attenuated virus, and finally 6) the reaction of immunized animals to virulent virus. Before each experiment, the animals' weight was determined, and both quantitative and spectroscopic blood tests were done. The air in the inhalation chambers was renewed every 0.5 hr. The methods employed for producing conditions 1-6 are described in detail. The results may be summarized as follows: 1) Inhalation, for a prolonged period of time, of more than 0.002% of Cl, 0.05% SO_2 and 0.05% N_2O_4, by animals, had the following effects: a) weight loss and change in the main blood constituents, b) decrease in the production of specific antitoxins and of the bactericidal power of the lungs, c) decrease of the resistance of the susceptible animals to infectious diseases, d) the immunized animals became susceptible to infectious diseases, 2) inhalation for a prolonged period of time of concentrations not exceeding those mentioned above had no effect on the exposed animals. Thus, these concentrations may be considered as the maximum tolerated concentrations under the given conditions. In the conclusion, the author suggests an explanation for the fact that the inhalation of higher concentrations enhances the predisposition of the organism to infectious diseases. The effects on the cells bring about a functional change in the tissues and organs which, in turn, influences the metabolism. Thus, the organism is weakened and the resistance is decreased. However, these are highly complicated processes of partly biochemical nature, and more elaborate experimental and clinical study is necessary to give a clear picture of these reactions. - KB

610. Schrenk, H.H.: Industrial hygiene. Indust. Eng. Chem. 46:103A (Feb.) 1964.

The broad scope of activities in the field of industrial hygiene in 1953 is evidenced by numerous reports on a wide variety of subjects such as analytical methods for air contaminants and biological specimens, toxicity of insecticides and other organic compounds, lead and other metallic elements, treatment of poisoning, and design of preventive measures. Some of the more interesting developments are presented in the following paragraphs: New treatment for lead poisoning; Mercury poisoning; Insecticides; Noise and Sulfur dioxide. - Author's Abst.

611. Sulfuric Acid Bulletin vol. 4, no. 9, 1956. New Jersey State Department of Health, Bureau of Adult and Occupational Health. A.M.A. Arch. Environ. Health 13:524 (May) 1956.

The subject of the latest of New Jersey's Bulletins of Occupational Health deals with occupational health hazards associated with sulfuric acid. It is stated in the introduction that "from the standpoint of industry, sulfuric acid (H_2SO_4) is probably the most important of all industrial compounds. There are very few manufactured articles which do not have some part that has been treated with or that comes into contact with this acid." Properties, methods of manufacture and uses of sulfuric acid are discussed in the bulletin. The toxicology, sensitivity, methods of determination and of control are also outlined. There is a bibliography on sulfuric acid and its use.

612. Viikeri, M.: X-ray changes in the lungs of workers in a foundry exposed to sulfur dioxide. Zentr. Arbeitsmed. u. Arbeitsschutz 6:60-1, 1956.

Pulmonary X-ray examinations were made of 53 foundry workers of the average age of 45.9 yr. who had been working continuously for 10 yr. (average period 15.2 yr.) in an atmosphere containing SO_2 in a concentration which did not exceed the standard of 10 ppm, although it did on occasion become considerably greater than this for short times. The controls were 37 workers who had been exposed only occasionally to SO_2, and these were divided into two groups, one of 20 men of the average age of 46.2 yr. and the other group consisted of 17 men of the average age of 33 yr. who had worked for 10 yr. A normal X-ray picture was found in only 7 of the 53 exposed workers, whereas 6 out of 20 in the 1st group of controls and 14 out of 17 in the 2nd group showed no abnormality. The chief pathological findings in the 53 exposed workers were 4 cases of fibrosis, and 17 cases in which the hilum was enlarged and thickened without other evidence of disease. There were several cases of emphysema and of cardiac disease. Evidence of old pulmonary t.b. was found in ca. 1/3 of the 53 exposed workers, but also in 11 of 20 of the 1st group, and in 2 out of 17 in the 2nd group of controls. - KB

613. Firket, M.: The cause of the symptoms found in the Meuse Valley during the fog of December 1930. Bull. Royal Acad. Med. Belgium 11:683, 1931.

Certain symptoms common to all were painful irritation often mounting to an active retrosternal pain, and extending along the outer edge of the ribs; attacks of coughing, dyspnoea, often paroxysmal; and prolonged expiration. Adrenalin often gave relief. Those previously affected with asthma or heart disease developed symptoms of shock. In addition to the tracheobronchopulmonary irritation, a large number showed signs of laryngeal irritation causing cough and modification of the tone of the voice. There was also some nausea and vomiting, lacrimation, and tenacious sputum. In one case there was desquamation of the mucosa of the entire buccal cavity. There was no diarrhea, neuritis, albuminuria, hepatomegaly or sensory disorders. "There is no reason to believe that only the ill and the aged were seriously affected by the toxic attacks." Persons were attacked who had not left their houses for several weeks or who had not gone out in the fog. At autopsy there was congestion of the mucous membranes of the air passages. All the symptoms and all the lesions found could be sufficiently explained by a local irritation of the exposed mucous membranes. - APCA

614. Firket, J.: Fog along the Meuse Valley. Trans. Faraday Soc. 32:1192, 1936.

Between December 1 and 5 of 1930, a heavy fog covered a large part of Belgium. A number of people were made ill; several hundred were severely attacked with respiratory symptoms, and 63 died on December 4th and 5th after only a few hours of illness. Many cattle had to be slaughtered. On December 6, the fog disappeared. Public opinion was deeply affected by the episode, and an investigation was started immediately. All the sick people felt retrosternal pain, had fits of coughing, and dyspnoea, and some had asthmatic attacks. In those who had asthma, cardiovascular collapse and symptoms of shock complicated the picture. In those who did not have asthma, hyperpnea, cyanosis and a tendency to frothy sputum developed. The autopsy reports indicated that the noxious substance was inhaled during the last few hours of life. The first symptoms began on the third day of the fog. Respiratory symptoms disappeared on the sixth day when the fog abated. Symptoms were observed by the people throughout the valley at about the same time. Chemical Analyses: The chemists found thirty substances polluting the atmosphere, with maximum concentrations reached by carbon monoxide, carbon dioxide, nitrous gases, sulfur dioxide, and hydrogen fluoride. Through deduction, observation, and data obtained, sulfur dioxide appeared to be issued in the largest amount in the whole valley as a result of burning coal. Part of the sulfur dioxide was oxidized into sulfuric acid. Only by the action of sulfur pollution could the simultaneous illnesses occurring along the entire valley be explained. The pathological findings also favored sulfur dioxide and sulfur trioxide as the offending gases. - APCA

615. Haywood, J.K.: Injury to vegetation and animal life by smelter waste.USDAB 113,1910.

This is a report of a study to determine the injurious effects which wastes from plants smelting sulfide copper ores may have on vegetation and animal life. Effects of sulfur dioxide on certain vegetation were first determined experimentally to see if sulfur dioxide was actually injurious and the type of injury it caused. Observations of actual damage were made at and around the Anaconda, Montana, smelter. In the experimental investigation, sulfur trioxide content in foliage was determined and compared with controls, and in all cases the exposed trees contained a higher concentration than the controls.

In the field investigation, observations as to general appearance, types of growth, and sulfur trioxide content, were made of foliage about the smelter. These observations were made during the summer of 1908. General conclusions included: (1) From actual chemical analysis it appeared that the forests extending at least 10 miles north, 11½ miles east, 9½ miles south, and 15 miles west, of the smelter were injured. (2) It was noted that the junipers were very resistant to smelter fumes, while the red firs were very susceptible and were badly damaged at distances of from 18 to 19 miles from the smelter; the lodge pole pines were damaged for at least 10 or 11 miles. (3) Large quantities of arsenic were discharged from the smelter and settled on the grass of cattle ranges as far as 15 miles away. Such arsenical grasses are not a suitable feed for cattle. - BAAP

616. Schnurer, L.: Effects of inhalation of smoke from common fuels. Am. J. Pub. Health 27:1010-1022, 1937.

Into each of 4 gas-tight exposure chambers were placed 4 rabbits and 8 rats. 17 da. before the end of the experiment 4 mice were added to each chamber. One of the chambers was used as a control and the other 3 vented with the flue gases from the burning of the same weight of anthracite (nut), coke (domestic) and bituminous coal (ca. 35% slack), respectively. The average concentrations of the constituents in the air-gas mixtures were: for anthracite 20.6% O_2, 0.4% CO_2, 1.91 ppm SO_2 and 312 particles dust/cc.; for coke 20.1% O_2, 0.5% CO_2, 9.12 ppm SO_2 and 370 particles dust/cc.; for bituminous coal 20.0% O_2, 0.6% CO_2, 7.51 ppm SO_2 and 4,410 particles dust/cc. and for control 125 particles/cc. and usual atmospheric concentrations of the gases. The maximum and minimum concentrations are also given. The animals were exposed 23 hr./day for 80 da. and fed a balanced diet. The following are the results as summarized by the author. Considering the weight gain of the control animals as 100%, the anthracite rats gained 105%, the coke animals gained 114%, and the bituminous group 75%; among rabbits, the anthracite gain was 84%, coke 77% and bituminous coal 9%. The % of hemoglobin and the number of red and white blood cells/mm.^{3} of blood rose consistently in all groups of animals, but this rise was least noticeable in the anthracite rabbits. The most immediate and pronounced blood changes occurred in the direction of leucocytosis, hemoglobin and erythrocytic increase in the animals subjected to bituminous coal. Intermediate deviations were seen in the coke group. Phagocytosis of C pigment in the lungs of the control animals was scarcely seen. It was slight in the animals exposed to anthracite, more obvious in those of the coke chamber and very marked in those subjected to bituminous coal smoke. The greatest number of uncomplicated pneumonias, and the greatest incidence of bronchitis occurred among the animals exposed to the products of combustion of bituminous coal. Not even the faintest suggestion of fibrosis of the lungs was seen in the control animals or those exposed to anthracite or coke. In the lungs of animals exposed to bituminous coal, spindling of C-laden cells--apparently the earliest stage of fibrosis--was noticed. It seems likely that soft coal, even when unaccompanied by other dusts, is capable of producing fibrosis if exposure is sufficiently prolonged. It is stated that the results justify further and more complete studies along the same line. - KB

617. Smoke and fume investigations - A historical review. R.E. Swain. Indust. Eng. Chem. 41:2384-2388 (Nov.) 1949.

This review has been limited to a few outstanding cases of injury to animal and plant life by emanations from industrial plants at Ducktown, Tenn., Anaconda, Mont., Salt Lake City, Utah, and Trail, B.C. At Anaconda injury by sulfur dioxide began to appear on the red fir and lodgepole pine. The smelters at Ducktown and in Montana had a daily output of 1000 tons or more of sulfuric acid. In Utah lead and sulfur trioxide fumes were put under control by liming and bag filtration, and by electrical precipitation. Regulations were put into effect and each plant was to discharge its gases through a stack at least 450 ft. in height; give buoyancy to escaping gases by maintaining throughout the growing season for vegetation in that area, between sunrise and sunset, a difference in temperature of at least 75° C between the stack gases and the outside air; and subject all emanations from smelting operations to electrical precipitation by the Cottrell process, bag filtration, or any other process of equal efficiency for the removal of suspended solids and mists. Trail, B.C., experts studied every known process for sulfur dioxide recovery and for making sulfuric acid and ammonia. About $13,000,000 were invested in recovering airborne waste and converting them to marketable by-products. Phosphate fertilizers of several types, ammonium sulfate, and sulfur were produced on a large scale. The Laboratory for Agricultural Research near Salt Lake City has for over 3 decades studied atmospheric pollution and remedial measures at its company's many plants over the country and has published many papers, covering research in plant fumigation and the development of procedures of the highest accuracy in experimental work in that field. The recorder, developed by Thomas of that group, is now widely employed in sulfur dioxide determinations. This analytical robot makes a determination of sulfur dioxide and records it automatically every 20 min. Later designs record a determination every 10 or 15 sec. and are adapted also to the estimation of total gaseous sulfur compounds in the air. - APCA

9. EXPERIMENTAL ANIMAL EXPOSURE TO SO_2

618. Amdur, M.O.: Effect of a combination of sulfur dioxide and sulfuric acid on guinea pigs - A preliminary report. Pub. Health Rep. 69:503-506 (May) 1954.

It has been shown that for 8 mg. per cu. m. of sulfuric acid mist and 89 ppm. of sulfur dioxide given in combination to guinea pigs the effect on growth, lung pathology, and respiration are much more marked than would be predicted from the use of either alone. - Author's Sum.

619. Amdur, M.O. and Mead, J.: A method for studying the mechanical properties of the lungs of unanesthetized animals: Application to the study of respiratory irritants. Proc. Third National Air Poll. Symposium, Pasadena, Calif., April 18-20, 1955.

We have presented a new method for the toxicologic study of respiratory irritants using unanesthetized guinea pigs as experimental animals. This method makes possible studies of subthreshold concentrations for the first time. Using sulfur dioxide as an example we have presented the type of data it is possible to obtain using this method. We have demonstrated that sulfur dioxide produced bronchial constriction in our animals and that these changes could be related to concentration. We demonstrated that the upper airway provides partial protection against sulfur dioxide, since a given atmospheric concentration reaching the lungs through a tracheal cannula produces effects far greater than would have been predicted on the basis of the reaction of the normal animal. - Author's Sum.

620. Amdur, M.O.: The influence of aerosols upon the respiratory response of guinea pigs to sulfur dioxide. Am. Indust. Hyg. A. Quart. 18:149-155 (June) 1957.

The increase in pulmonary flow resistance caused by an hour exposure has been used to study the response of guinea pigs to sulfur dioxide alone and in combination with sulfuric acid mist and sodium chloride aerosols. The degree of response to a mixture of sulfuric acid of sub-micron particle size and sulfur dioxide was greater than could be accounted for on the basis of simple addition. This was not the case when sulfuric acid of 2.5 micron particles was used. Sub-micron aerosols of sodium chloride, inert alone, increased the response to all concentrations of sulfur dioxide studied. The potentiating effect was much greater at concentrations below 25 ppm sulfur dioxide than would have been predicted on the basis of data obtained from the higher concentrations. - Author's Abst.

621. Amdur, M.O., Schulz, R.Z. and Drinker, P.: Toxicity of sulfuric acid mist to guinea pigs. Arch. Indust. Hyg. & Occupat. Med. 5:318-329, 1952.

The apparatus used in exposing the guinea pigs to H_2SO_4 mist is illustrated. Mean particle size was determined to be ca. 1µ which is comparable to 0.75µ, the H_2SO_4 particle size found in Los Angeles atmosphere. Two groups of guinea pigs were exposed for 8-hr. periods. LD_{50} for 38 guinea pigs 1.5 yr. old was 50 mg. $H_2SO_4/m.^3$ air, and LD_0 was 20 mg./$m.^3$ concentration. For 62 guinea pigs 1-2 mo. old, LD_{50} was 18 mg./$m.^3$, and LD_0 was 8 mg./$m.^3$. The difference in LD_{50} for the young and old groups is statistically significant. Autopsies were performed immediately on the animals that died during exposure. Gross observation showed areas of hemorrhage in the lungs, nose (at higher concentrations) and adrenal glands, while other organs appeared normal. Microscopically, the lungs revealed hemorrhage and edema. More detailed observations are given. Animals surviving exposure were killed at various intervals up to 3 wk. Grossly, the lungs of these animals disclosed spotty areas of consolidation. Histologically, these lungs showed a general picture of pneumonic changes and fibrosis. Guinea pigs 1-2 mo. old were exposed for continuous periods up to 72 hr. No mortality occurred at a concentration of 8 mg. $H_2SO_4/m.^3$ air up to 72 hr. exposure. The mortality rate changes very little at concentrations of 12 and 16 $mg./m.^3$ for exposures lasting from 8-72 hr. At concentrations $\leq$ 20 $mg./m.^3$, mortality rates increased rapidly. The surviving animals were killed at various intervals up to 3 wk. after the end of the exposure period. The changes were of the same type as those found in the 8-hr. exposures. Photomicrographs comparing lung section of controls and animals exposed for 8 hr. and for 72 hr. are given. The 2 distinct toxic actions of H_2SO_4 mist are discussed. H_2SO_4 mist produces laryngeal spasm and also causes deep-seated damage of the lungs. The 1st action is the immediate cause of the high mortality rate. This action depends on concentration of H_2SO_4 much more than on time of exposure. The severity of the lung damage is dependent on total dosage rather than on concentration alone. A concentration of 8 $mg./m.^3$ given for 72 hr. (concentration X time-576) produces much more extensive lung damage than does a concentration of 20 $mg./m.^3$ given for 8 hr. (concentration X time-160), although no mortality is produced by the 1st dose and 50% mortality is produced by the 2nd dose. The lung damage is still observed as long as a mo. after a single exposure. - KB

622. Amdur, M.O.: The respiratory response of guinea pigs to sulfuric acid mist. A.M.A. Arch. Indust. Health 18:407-414 (Nov.) 1958.

The physiologic response of guinea pigs to inhalation of sulfuric acid mist in concentrations of 2 to 40 mg./cu.m. for periods of one hour was studied. Three particle sizes were used, 0.8 micron, 2.5 microns, and 7 microns. Particles of 7 microns produced only a slight response even at concentrations of 30 mg./cu.m., since they do not penetrate beyond the upper respiratory tract. At high concentrations the 2.5 microns particles caused a greater response than the 0.8 micron particles. At concentrations approaching more practical significance, namely 2 mg./cu.m., the smaller particles cause a greater response. The 0.8 micron particles produce an immediate response, and the increase in pulmonary flow resistance is proportionally greater than the decrease in compliance of the lungs. Such mechanical behavior suggests bronchial constriction as the physiologic mechanism involved. In this respect the submicron aerosol behaves in a manner similar to the irritant acid gases. The response to the larger particles was delayed in time, and the increase in resistance was accompanied by a major decrease in compliance. Exposure to high concentrations resulted in severe atelectasis and edema. Such responses are interpreted as plugging and closure of the main bronchi rather than as more evenly distributed bronchial constriction. The differences in response to the three particle sizes of sulfuric acid mist are consistent with what would be predicted from information on the degree of penetration and site of deposition of aerosols of various particle sizes. The effect of sulfuric acid on respiratory work is discussed. Data are given on the response of a group of animals to concentration of sulfuric acid mist which produced death within an hour. - Author's Sum.

623. Amdur, M.O.: The physiological response of guinea pigs to atmospheric pollutants. Internat. J. Air Poll. 1:170-183, 1959.

Changes in the mechanical behavior of the lungs were produced by 1 hr. exposure of guinea pigs to low concentrations of irritant air pollutants. Sulfur dioxide acetic acid, formaldehyde, formic acid and 0.8 μ sulfuric acid produced bronchial constriction, whereas 2.5 μ sulfuric acid resulted in obstruction of some of the larger air passages.

As evaluated by the increase in pulmonary flow-resistance and the increase in work of respiration the most potent of the gaseous irritants was formic acid, followed by formaldehyde, acetic acid, and sulfur dioxide in that order. Extension of the exposure time indicated that the response to sulfur dioxide continued to increase during a 3 hr. exposure, whereas prolonging the formaldehyde exposure to 4 hr. indicated that the maximum response was produced in 1 hr.

In the case of sulfur dioxide, acetic acid, and formaldehyde the response was greater when the gases were breathed through a tracheal cannula, thus bypassing the scrubbing effect of the upper respiratory tract.

Using mixtures of sulfur dioxide and sulfuric acid mist, a synergistic toxic action was observed when the sulfuric acid particle size was 0.8 µ but not when 2.5 µ sulfuric acid was used. A potentiation of the response to sulfur dioxide was obtained with sodium chloride aerosol of 0.04 µ but not with 2.5 µ, hence particle size appears to be an important factor in the potentiation of the response to irritant gases by aerosols. The possible reasons for this are discussed.

When the four irritant gases used were studied in combination with 10mg/m^3 sodium chloride of 0.04 µ diameter which was itself without effect on the animals, the response to sulfur dioxide and to formaldehyde was potentiated but the response to acetic and formic acids was unchanged. The aerosol, however, prolonged the response after the termination of the exposure in the case of all four gases.

The response to the combination of formaldehyde plus aerosol was greater than the response to the gas alone breathed through a tracheal cannula. The presence of a trachea cannula used with the gas-aerosol mixture produced an increase exactly accounted for on the basis of the gas alone. At a given concentration of formaldehyde the response produced varied with the aerosol concentration. These experiments indicate that the increase of toxicity of a gas-aerosol mixture can be definitely related to the aerosol entity. - Author's Abst.

624. Amdur, M.O.: The response of guinea pigs to inhalation of formaldehyde and formic acid alone and with a sodium chloride aerosol. Internat. J. Air Poll. 3:201-220, 1960.

One hour exposures of guinea pigs to formaldehyde or formic acid produced an increase in resistance and a decrease in compliance which were statistically significant at concentrations as low as 0.3 ppm. A decrease in respiration rate and minute volume also occurred, but these factors did not change significantly until concentrations above 10 ppm were used. An increase in respiratory work was observed, the greater proportion of the increase being in the resistive component. These changes became statistically significant at 1-3 ppm. Evaluated by these criteria, formic acid is a more potent respiratory irritant than formaldehyde. The resistance values returned to pre-exposure control values by the end of an hour after exposure except at the highest concentrations used (40-50 ppm). When the protective effect of the upper airway was bypassed with a tracheal cannula, the response to a given concentration of formaldehyde was increased. The resistance change was again reversible in an hour after the exposure ended.

The response to formaldehyde was potentiated by the presence of an aerosol of sub-micron particle size sodium chloride which was itself inert. The response to this combination was greater than the response to the gas alone breathed through a tracheal cannula. A tracheal cannula used with the gas-aerosol combination produced an increase exactly accounted for on the basis of the increased response to that concentration of gas alone. The sub-micron sized aerosol would not be removed by the upper respiratory tract, hence the potentiation due to the aerosol entity would be the same in normal and tracheotomized animals. The resistance remained elevated an hour after the exposure was terminated in animals exposed to the combination of formaldehyde and aerosol formaldehyde was used with three different aerosol concentrations, 3, 10, and 30 mg/m^3.

The potentiation observed increased with increasing aerosol concentration, but attained a limiting value at each aerosol level once a critical gas concentration was reached. The response to formic acid during exposure was not potentiated by the aerosol, but the resistance values remained elevated an hour after the exposure ended when the combination was used. - Author's Abst.

625. Amdur, M.O.: The respiratory response of guinea pigs to the inhalation of acetic acid vapor. Am. Indust. Hyg. A. J. 22:5 (Feb.) 1961.

Guinea pigs exposed for one hour to concentrations of 5 to 500 ppm of acetic acid vapor showed an increase in pulmonary flow resistance, a decrease in pulmonary compliance, and an increase in the time constant of the lungs. These changes suggest bronchial constriction as the primary action of this irritant. Concentrations above 100 ppm also caused a decrease in respiration rate and minute volume and an increase in the work of respiration. Bypassing the upper airway with a tracheal cannula increased the response. A sodium chloride aerosol delayed the recovery but did not increase the magnitude of the response. - Author's Abst.

626. Amdur, M.O.: The effect of aerosols on the response to irritant gases. In Davies, C.N. (editor): Inhaled Particles and Vapors. Proc. Internat. Symposium, Oxford, 29 March - 1 April, 1960. Pergamon Press, Oxford, England, 1961.

The increase in pulmonary flow-resistance in unanesthetized guinea pigs by a one-hour exposure has been used to evaluate the response to irritant gases alone and in combination with a sodium chloride aerosol of sub-micron particle size which is itself physiologically inert.

Both sulfur dioxide and formaldehyde are potentiated by the aerosol. This potentiation is believed to result from an association of the irritant gas with the aerosol particles, thus creating an irritant aerosol. At a given gas concentration, the increment in response is related to the concentration of aerosol added. The added response cannot be explained merely on the basis of an increased amount of gas reaching the lungs, the fact that even a small amount reaches the lungs associated with an aerosol is the critical factor. In the case of formaldehyde the potentiation is evident after ten minutes of exposure, whereas it only becomes apparent after a longer exposure in the case of sulfur dioxide. The presence of the aerosol delays the return of the resistance to control values. - Author's Abst.

627. Amdur, M.O. and Corn, M.: The irritant potency of zinc ammonium sulfate of different particle sizes. Am. Indust. Hyg. A. J. 24:326-333 (July-Aug.) 1963.

Aerosols of zinc ammonium sulfate cause an increase in pulmonary flow resistance in guinea pigs exposed for one hour. Zinc sulfate and ammonium sulfate have similar actions but are less potent irritants than the double salt. Zinc ammonium sulfate aerosol was studied at mean particle sizes by weight of 0.29, 0.51, 0.74 and 1.4 μ. The smaller the particles, the greater the irritant action at any given mass concentration. When the number of particles per unit volume is equal, the larger aerosols are more irritating. When zinc ammonium sulfate (0.3 μ) and sulfur dioxide were administered together the response to the mixture was more than additive. - Authors' Abst.

628. An, A.S.: The effect of sulfur dioxide gas on vitamin C balance in animals. Gig. i Sanit. 25:35-40 (March) 1960, in: Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U. S. Depart. of Commerce, Office of Technical Services, Washington, D. C., Vol. 5, pp. 102-107, (Jan.) 1961.

The vitamin C content of the blood was determined in experimental animals both before and after their poisoning with sulfur dioxide gas. After 3 hrs. of poisoning there was a rapid fall in the level of vitamin C in the blood. Poisoning (0.4-0.5 mg./l.) for 4-9 days, 3-6 hrs. a day, 1st produced a rise in the vitamin C content, then a decrease for 4-5 times with the original level recovered only on the 10-15th day. Administration of ascorbic acid or thiamine before or during the poisoning produced a sharp fall of the vitamin C content. Similar results obtained with rabbits and guinea pigs showed that a rise in vitamin C content after a prolonged poisoning was not the result of its high synthesis but was due to the hydroloysis of the combined ascorbic acid. - APCA

629. Asset, G.: Effect of particle size and wind speed on nasal penetration of wind borne particles. A.M.A. Arch. Indust. Health 15:119-123 (Feb.) 1957.

Percentage nasal penetration of particles was studied as a function of particle size and wind velocity in dead dogs. The influent concentration of the aerosol flowing into the noses was determined by a sampler made in the shape of a dog's head. The nasal penetration, i.e., the ratio of the effluent concentration to that of the influent concentration, was significantly greater for the smaller particle size and for the smaller wind velocity. Values of nasal penetration are also presented based on the concentration of the affluent aerosol, i.e., the aerosol in the air moving toward the animal. These values are smaller than those obtained from concentrations of the influent aerosol. - APCA

630. Asset, G.: Nasal sampling of aerosols in experimental animals. A.M.A. Arch. Indust. Health 18:460-463 (Dec.) 1958.

Two independent experiments are described of nasal sampling, or particle intake, in the guinea pig and the dog. Special samplers were made the same size and shape as the heads of the species under study. In 1 of the experiments, the aerosol was drawn from a moving air stream into the special sampler, the velocity of which was adjusted to be the average of the flow into for 1 inspiration; in the other experiment, by means of a fluctuating flow simulating the breathing pattern. Although the 2 experiments were done under different conditions, the results were in general agreement. The ratio of the concentration of the influent aerosol to the affluent aerosol, or the efficiency of particle intake, decreased with increasing particle size and decreased with increasing wind velocity. The more extensive experiments brought out further trends: the existence of an optimum particle size for which the particle intake is over 100%, and the existence of a max. particle size above which no particles are drawn into the nose during the breathing cycle. - Author's Sum.

631. Atiakina, I.K.: The combined action on the body of small concentrations of sulfur dioxide gas and of high air temperature. Gig. i Sanit. 24:26-32 (Oct.) 1959.

The author has studied the prolonged, combined action on the body of sulfur dioxide and of the high temperature of the surrounding air. The investigation included a clinical blood test; analysis of protein fractions of blood serum by means of electrophoresis on filter paper; a determination of the phagocytic activity of blood leukocytes; and the vitamin C content of tissues. As a result of the investigations the following has been determined. The phagocytic activity of blood leukocytes in workmen who were investigated at a chemical plant in Shchelkovo was lower than in persons of a control group. When experimental animals inhaled sulfur dioxide gas at a concentration of 0.08-0.1 and 0.02 mg./l., at a temperature of 35-40°C., there was a fall in the phagocytic activity of blood leukocytes, anemia, and changes in the ratio of protein fractions of the blood serum. Inhalation by experimental animals of sulfur dioxide gas at a concentration of 0.005 mg./l. at the same temperature produced insignificant changes in the phagocytic activity of blood leukocytes; the blood picture and the general condition of the animals remained unaltered. - APCA

632. Balchum, O.J., Dybicki, J., and Meneely, G.R.: Measurement of pulmonary resistance and compliance with concurrent tissue radioactive sulfur distributions in dogs inhaling a labeled air pollutant-sulfur dioxide. Fed. Proc. 18:6 (March) 1959.

Dogs inhaled $S^{35}O_2$ labeled SO_2 gas in air in concentrations from 1 to 150 ppm via a tracheostomy for 20 - 40 min., with measurement of pulmonary resistances and compliances before, during and for 30 min. after exposure. Autopsies were then done and tissues analyzed for S^{35}. No changes in pulmonary compliance were observed. Pulmonary resistance increased by 50 - 125% over control levels within 10 seconds after onset of exposure. S^{35} was present in all tissues examined. The percent uptake of the administered dose, for example, was: trachea 42%, lungs 2.6%, hilar lymph nodes 1.7%. S^{35} was found in the brain (2.8%), eye (0.3%), liver (5.7%), spleen (0.7%) and kidneys (6.0%). Peripheral arterial and venous blood levels done serially showed a gradual rise after onset, and a slow fall after the end of exposure. S^{35} reached all tissues readily and penetrated the blood-brain barrier. In view of the rapid onset and abrupt cessation of its effects, the mechanism of action of SO_2 must be a local one, either directly or by nervous reflex action. - Authors' Abst.

633. Balchum, O.J., Dybicki, J., and Meneely, G.R.: Absorption and distribution of $S^{35}O_2$ inhaled through the nose and mouth by dogs. Am. J. Physiol. 197:1317-1321 (Dec.) 1959.

Dogs breathing $S^{35}O_2$ through the nose and mouth retained a smaller proportion of the inhaled gas in the trachea, lungs, hilar lymph nodes, and liver and spleen than those breathing similar concentration via a tracheostomy. This conclusion is substantiated by tissue S^{35} concentration assays, and measurements of the compliance of the lungs and thorax, and of pulmonary resistance. The upper airways therefore partially protect the lungs from exposure to sulfur dioxide. - Authors' Abst.

634. Balchum, O.J., Dybicki, J., and Meneely, G.R.: Pulmonary resistance and compliance with concurrent radioactive sulfur distribution in dogs breathing $S^{35}O_2$. J. Appl. Physiol. 15:62-66 (Jan.) 1960.

Ten dogs breathed $S^{35}O_2$ via a tracheal cannula in concentrations ranging from 1.8 to 148 ppm. There was a decrease in the compliance of the lungs and thorax after 10-15 min. of inhalation, and an immediate and marked increase in the nonelastic resistance to breathing. S^{35} was found to be highest in concentration in the trachea, lungs, and hilar lymph nodes, and next highest in the kidneys and esophagus. A relatively uniform and low concentration was noted in other tissues, such as the heart muscle, liver, spleen and striated muscle. $S^{35}O_2$ when inhaled was absorbed quickly, distributed widely to many tissues, and readily gained access to many tissues including the brain. - APCA

635. Balchum, O.J., Dybicki, J., and Meneely, G.R.: The dynamics of sulfur dioxide inhalation absorption, distribution, and retention. A.M.A. Arch. Indust. Health 21:564-569 (June) 1960.

The combustion of coal and fuel oil has resulted in a contamination of the atmosphere by SO_2, amounting to as much as 2000 tons/day in a large city such as New York. The effects of the chronic inhalation of low concentrations of this substance are of particular importance, as urban atmospheric concentrations usually do not exceed 0.5 to 1 ppm. This report is concerned with 3 aspects of interest in regard to SO_2 transfer: (1) the extent of absorption of SO_2 from the trachea when it alone is exposed to SO_2, (2) the length of time that SO_2 can remain in the tissues, and (3) the distribution of $Na_2S^{35}O_4$ when injected into the blood stream, in contrast to the distribution after $S^{35}O_2$ inhalation. Two dogs were prepared so that an isolated segment of the trachea could be perfused with an $S^{35}O_2$ air-gas mixture, without the mixture entering the main -stem bronchi or lungs. SO_2 is readily absorbed from the upper and lower respiratory tract even when inhaled in low concentrations, 1 ppm. It can be absorbed by the tracheal mucosa when the latter alone is exposed to a degree sufficient detrimentally to influence pulmonary function. After absorption from the sites of deposition in the trachea, bronchi and lungs, it is distributed to all tissues, including the brain. It can still be detected in the trachea and lungs, 1 week after exposure. The physiologic and metabolic effects of the prolonged inhalations of low level concentrations of SO_2 are unknown, and experiments are now in progress in an attempt to obtain further data on this aspect of the effects of the inhalation of low concentrations of SO_2. - APCA

636. Ball, C.O.T., Heyssel, R.M., Balchum, O.J., Elliott, G.O., and Meneely, G.R.: Survival of rats chronically exposed to sulfur dioxide. Physiologist 3:15 (Aug.) 1960.

Three hundred and five male rats were randomly assigned to constant temperature humidity controlled exposure chambers chronically breathing 0, 1, 2, 4, 8, 16 and 32 ppm SO_2. The rats are transferred daily to clean, serviced cage racks, are carefully examined and weighed weekly with hematologic studies quarterly and pathologic studies at death. Incidence and degree of wheezing, eye opacities, loss of fur and scaley tails are associated with sulfur dioxide concentrations. The control group maintains the best weight. White blood cell counts, per cent neutrophils and hemoglobin are elevated in the SO_2 exposed groups. After 8 months, all of the control group, 93% of the 1-16 ppm groups and 82% of the 32 ppm groups were alive. At 12 and 16 months the corresponding per cent survivals were 91 and 75% among the controls; 84 and 68% in 1-16 ppm SO_2 groups and 58 and 44% in the 32 ppm SO_2 group. - Authors' Abst.

637. Barnes, J.M.: Mode of action of some toxic substances. With special reference to the effects of prolonged exposure. British Med. J. pp. 1098-1104 (Oct. 28) 1961.

Intermittent or more continuous exposure to chemicals with a tremendous variety of biological properties is undergone by many people during their work in industry, their life in our cities, and even in the privacy of their homes. In some polluted atmospheres the quantities of toxic materials seem to border on those demonstrably hazardous. In others--for example, the field of food additives--most of the materials appear by current standards to be virtually harmless. In other situations, particularly where occupational exposure is concerned, the chemicals may produce some deviation from normal the significance and importance of which are at present not fully understood.

Unfortunately, there are only very limited resources available either in this country or overseas for the experimental study and proper analysis of the properties and mode of action of toxic substances. In recent years the balance of this effort has been grossly disturbed by the current clamour about the safety of chemicals used as food additives (Mulford, 1961). Increasingly greater laboratory facilities are being devoted to the carrying out of set procedures to show that substances almost biologically inert can be tolerated by rats and dogs for years on end. There are, however, still quite a number of really poisonous materials, particularly in the environment of those in certain occupations. It is surely important to see that, in this country at least, more attention will be paid to the problems presented by such materials. - Author's Concl.

638. Brieger, H. and LaBelle, C.W.: The fate of inhaled particulates in the early postexposure period. A.M.A. Arch. Indust. Health 19:510-515 (May) 1959.

When animals or men are exposed to noxious agents in the form of airborne particulates, significant amounts of material are deposited at sites other than the lung and, moreover, there may be appreciable interchange of material between such sites during early postexposure period. Rats were exposed to an atmosphere containing insoluble dye particles at 20 mg./m.^{3} for 7 hr. and the body tissues examined for dye content for periods up to 2 weeks. A redistribution of the particles took place during and after the exposure, with the result that 3 distinct phases, could be differentiated. In the early period, during and immediately after exposure, the largest amount of dye was found on the skin, a smaller in the gastrointestinal tract, and the smallest absolute amount in the lung. Studies based on intratracheal injection indicated that the gastrointestinal burden during this phase included material transported from the lung to the intestine by secondary mechanisms. In the last phase, after 10-14 days, dye was found only in the lung. The true site of exposure thus changed from the skin to the gastrointestinal tract to the lung. The importance of each of these areas of contact will depend on the properties of the noxious agent involved. - APCA

639. Bushtuyeva, K.A.: Ratio of sulfur dioxide and sulfuric acid aerosol in atmospheric air, in relation to meteorological conditions. Gig. i Sanit. No. 11, pp. 11-13, 1954, in: Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U.S. Department of Commerce, Office of Technical Services, Washington, D. C., Vol. 4, August 1960, pp. 193-196.

A direct correlation between sulfur dioxide and sulfuric acid content was found when examination was made of concentrations of sulfur dioxide and sulfuric acid aerosol sampled from the environment around Moscow under various types of weather conditions. The aerosol concentration rose greatly during calm weather. The toxic principle in several recorded smogs may be ascribed to the highly toxic sulfuric acid aerosol formed from the airborne sulfur dioxide.

640. Bushtueva, K.A., Polezhaev, E.F., and Semenko, A.D.: Electroencephalographic determination of threshold reflex effect of atmospheric pollutants. Gig. i Sanit. 25:57-61, 1960, in: Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Diseases. A Survey. U. S. Dept. of Commerce, Office of Technical Services, Washington, D.C., Vol. 7, 1962, pp. 137-142.

This paper is a report of attempts to test suitability of the electroencephalographic method for the determination of unusual simple allowable concentration limits of air pollutants. As a first step tests were made of the effect of odor-emanating substances and other stimulating or irritating substances on reflex responses.

Substances investigated were SO_2 and H_2SO_4 aerosol. Investigations here reported point to a high sensitivity of the method of "electrocortical" conditioned reflexes as a procedure for the study of threshold effect of irritating and odor-emanating substances on the reflexogenic zone of respiratory organs.

641. Bystrova, T.A.: Effects of sulfur dioxide studied with the aid of labeled atoms. Gig. i Sanit. 22:30-37, 1957, in: Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U.S. Depart. of Commerce, Office of Technical Services, Washington, D.C., Vol. 1, Jan., 1960, pp. 89-97.

Following the inhalation of SO_2 by experimental animals, its S-containing conversion products, were rapidly distributed by the blood over the entire organism and deposited in the organs where they were retained for 11 days and longer, depending upon the original concentration inhaled or injected. The distribution of S among the organs showed no pattern or regularity, except for the fact that lung tissues retained it in concentrations higher than did any other organ. In subcutaneous injections the S deposited in the lungs was in the form of sulfites. Upon repeated inhalation of $S^{35}O_2$ its conversion products containing S showed a tendency to accumulate in the body organs. The results of the experiments substantiated the conclusions previously reported in the literature concerning the properties of the living organism to absorb SO_2.

The fact that products of SO_2 conversion became accumulated in the body organs leads to the assumption that daily inhalation of even low concentrations of SO_2 can develop pathologic processes in the organism.

642. Cameron, G.R.: Toxicity of chlorsulphonic acid-sulfur trioxide mixture smoke clouds. J. Path. & Bact. 68:197-204 (July) 1954.

The suggestion has been made that the harmful effects which resulted in London from the fog of 5th-8th December 1952 may have been due to an abnormal contamination of the atmosphere with the oxides of sulfur and especially with sulfur trioxide. This paper reports the results of some experiments carried out in 1943, in which observations on the toxic effects of chlorsulphonic acid-sulfur trioxide smoke mixture were made.
1. Various animal species were exposed to chlorsulphonic acid fumes. One species only, the guinea-pig, proved susceptible, dying from bronchial spasm, pulmonary edema and acute bronchitis. Residual bronchopneumonia was found in the lungs of guinea pigs which survived the experiment.
2. Persons not subject to pulmonary disturbance should prove resistant to chlorsulphonic acid smokes in relatively low concentrations in the open air. A hazard may, however, exist in human beings who suffer from asthma or allied conditions. High concentrations are not harmless. - Author's Sum.

643. Campbell, J.A.: Carcinogenic agents present in the atmosphere and incidence of primary lung tumours in mice. Brit. J. Expt. Pathol. 20:122-132, 1939.

In each case 75 mice were exposed to a moderate cloud of chimney soot and of exhaust soot for 10 min./hr., 6 hr./day, 5 day./wk. for a yr. 75 mice were also used as controls in each case. Experiments were also carried out in which 23-24 mice were painted twice/wk. with (a) 4 tar extracts (24 mice each) from road dusts for 6-7 mo.; (b) "tar" from cigarette smoke for 20 mo.; (c) benzene extract of cardboard for 12 mo.; (d) 2 tar extracts (24 mice each) from exhaust soot for 6-12 mo. and (e) tar from chimney soot for 6 mo. The mouse-skin tests showed that road dust tar contains potent carcinogenic agents as does chimney soot, but under ordinary conditions the effect of the latter in its action on the skin seems to be mitigated somewhat by the presence of the C of the soot, while the effect of the former seems to be aided by the presence of inorganic constituents. Of the 87 surviving mice, 16 of the skin cancer cases gave rise to metastases in the lung and primary lung tumors developed in 10 others. Under ordinary circumstances, the tar in cigarette smoke may occasionally produce hyperplasia and cancer of the skin after prolonged application. Seven (35%) of the mice surviving 10 mo. exhibited primary lung carcinoma. Tarry matters from the motor-exhaust soot and from the cardboard tested did not produce cancer when painted on the skin of mice, but 10 (50%) of the surviving mice painted with the former and 5 painted with the latter developed lung tumors. The results for primary lung tumors from the inhalation experiments, together with those done previously, are summarized. The % of normal control mice, living 10 mo. or longer, having lung tumors ranged from 8-20%; for those inhaling motor exhaust gases, 20 and 18%; chimney soot 26%; road dust for 1 wk. only, 30%; cigarette smoke, 30%; exhaust soot, 33%; road dust less tar, 45%; with tar, 74%; with tar plus CO, 47%. The age of the mice ranged from 664-919 da. It is considered that the inorganic constituents in the road dust (e.g., SiO_2, Fe) enhance or aid the effect of the tar, while, on the other hand, the C of soot tends to mitigate any effects of the tar present in producing tumors of the lungs. Irritation without inflammation appears to play a part in the genesis of these tumors both in control and experimental mice. Although some primary lung tumors in mice are simple adenomata, other tumors reveal characters of typical malignancy with production sometimes of metastases. Further examples of metastases have been obtained. - KB

644. Campbell, J.A.: Lung tumours in mice; incidence as affected by inhalation of certain carcinogenic agents and some dusts. British M. J. 1:217-221, 1942.

In each experiment 150 mice, 75 for the dusted group and 75 controls, were exposed in closed chambers to a moderate cloud of dust once/hr., 6 times/day, 5 day/wk. for 1 yr. The mice, equally divided as to sex, were 3 mo. old at start and allowed to complete their allotted span of life. Histological sections were made of all lungs, tracheobronchial glands and any organ showing pathological change. Dusts used were precipitated SiO_2 + methylcholanthrene, steel grindings, $Al_2O_3 + SiO_2 + Fe_2O_3$, Czechoslovak dust, $Al_2O_3 + SiO_2 + Fe_2O_3 + CaCO_3$, and tarred road dust. All the dusts increased the incidence of primary lung tumor in mice. The tarred road dust was obtained ca. 5 yr. after tarring; it still contained ca. 2% tar, but the carcinogenic agent, although still there, was not so active as in the experiment with freshly tarred road dust (Campbell, J.A.: Brit. J. Experimental Pathol. 15: 287-294, 1934). No skin cancer was produced by dusting alone. About a 9-fold increase in lung tumors was produced, there being 8 (13.1%) of the 61 dusted mice and 1 (1.4%) of the 69 control mice with tumors. The deposit of tarred dust in the lungs was moderate, in some of the lymph glands - very heavy. However, only hyperplasia occurred in these. - KB

645. Cohen, A.E., Scheel, L.D., Kopp, J.F., Stockell, F.R., Jr., Keenan, R.G., Mountain, J.T., and Paulus, H.J.: Biochemical mechanisms in chronic carbon disulfide poisoning. Am. Indust. Hyg. A.J. 20:303-323 (Aug.) 1959.

The threshold exposure concentration which will injure rabbits maintained on a good diet has been shown to be between 500 and 750 ppm when administered six hours per day, five days a week. Early evidence that CS_2 combines with free amino groups in the body to form thiocarbamate and thiazolidone groups is presented. The sequestering action of these groups on the zinc and copper content of the tissues and their effect on metabolism is discussed. The earliest toxic sign observed was loss of body weight which was followed in 6 to 14 weeks by loss of muscular control over voluntary movement of the lower back and rear quarters of the animal. The loss of muscular control was found to be due to lesions which developed in the spinal cord and brain tissue. These lesions were located in anatomical areas occupied by the pyramidal tracts of the spinal cord. Based upon the evidence presented, the biochemical mechanism for the injury caused by these exposures to CS_2 may be outlined as follows: (1) Reaction of CS_2 with amino groups of amino acids and protein to form thiocarbamate which cyclizes to thiazolidone. (2) Chelation of polyvalent inorganic ions by the newly formed complexing groups to such an extent that cellular metabolism is disturbed. (3) The interference with metabolism causes a stress response and shift in metabolism which results in loss of body weight and indications that the fat stores of the body are being utilized. (4) Ultimately cell death and loss of associated function produce signs of injury. The post exposure observations made indicate that little or no recovery of lost function was experienced during the period of observation although decided improvement in the tissue zinc and copper levels were observed. - Authors' Sum.

646. Cralley, L.V.: The effect of irritant gases upon the rate of ciliary activity. J. Indust. Hyg. & Toxicol. 24:193-198, 1942.

A method for the quantitative study of the effect of irritant gases on ciliary activity (excised tissue) is described. In the use of this method the temperature and humidity are controlled and the gas to be studied is passed over the tissue at a rate comparable to that of breathing by the experimental animal, viz., the rabbit. A comparison of the effect of SO_2 on freshly excised rabbit tissue with the effect of this gas on intact tissue in the human subject showed that the ratio of the response was the same. The intensity of the response was greater with excised tissue. The excised tissue was discarded when the elapsed time after death of the rabbit was greater than 2.5 hr., for the ciliated epithelium became increasingly susceptible to the effect of an irritant gas (SO_2) with the lapse of time after its removal from the rabbit. Excised tissue tested 7.5 hr. after its removal from the animal was 4 times as sensitive as tissue studied within 0.5 hr. after its removal, as shown on the basis of complete cessation of ciliary activity. The critical zone beyond which complete cessation of ciliary activity (excised tissue) takes place is relatively narrow as to concentration and time. After 5 min. exposure this zone in concentration of the gases studied was approximately 30 ppm Cl_2, SO_2 and HCHO; 60 ppm HCl and NO_2; 400 ppm NH_3; 500 ppm H_2S. The pH resulting from the dissolution of the active gases, e.g., NO_2 and Cl_2, in the aqueous layer covering the cilia is undoubtedly a factor in stopping ciliary activity. The immediate irritation of the throat on exposure to certain irritant gases (as reported in literature) offers a comparative index as to the depressing effect of these gases on freshly excised ciliated epithelium. The rate of removal of a drop of amaranth (a red dye) placed in the active ciliary region of the inferior meatus of a human subject was studied. The time interval between the introduction of the dye and its first appearance in the expelled mucus served as an index of the rate of removal. The rates when the subject breathed normal air and when he breathed a known concentration SO_2 for a given length of time before introduction of the dye were compared. It was found that exposure to 10-15 ppm SO_2 for 1 hr. produced only a small decrease in the rate of removal of the mucus, but at 25 ppm, the depression of ciliary activity was approximately 50% and exposures of 30 min. to 50 ppm produced a 65-70% depression of activity. It is suggested that exposure to small amounts of irritant gases for long periods of time may lead to a chronic irritation of the mucosa which would accordingly affect ciliary activity. - KB

647. Dalhamn, T. and Rhodin, J.: Mucous flow and ciliary activity in the trachea of rats exposed to pulmonary irritant gas. British J. Indust. Med. 13:110-113 (April) 1956.

Mucous flow and ciliary beat were studied in rats exposed to sulfur dioxide as a typical irritant gas. The rate of mucous flow was considerably reduced and the amount of secretion was greatly increased after ten weeks' exposure to 10 ppm of sulfur dioxide. The rate and phases of ciliary beat were unaffected. The ciliary structure as shown by electron microscopic studies was also unaffected. It would seem that the functional changes noted are primarily attributable to alterations in the character of the mucosal secretion and not to injury to the ciliary mechanism as such. - Authors' Sum.

648. Dalhamn, T.: Studies on the effects of sulfur dioxide on ciliary activity in rabbit trachea in vivo and in vitro and on the resorptional capacity of the nasal cavity. Am. Rev. Resp. Dis. 83:566-567 (April) 1961.

With lengthwise incised trachea, the animals were placed in a moist chamber. The rate of ciliary beat was registered with a high-speed motion picture camera (200 pictures per second). When the film was projected the seemingly slower rate of beat could be calculated and then computed to the true value.

The speed of mucus flow in the trachea was measured by the simple method of timing the passage of cells, et cetera, in the mucus between two points on a scale inserted into the occular of the microscope. The action of some respiratory irritant gases on the trachea was investigated by exposing rats to about 10 ppm sulfur dioxide daily for one to two months and at the end of that time measuring the speed of ciliary movement and of mucous transportation. - Author's Sum.

649. Dalhamn, T. and Strandberg, L.G.: Acute effect of sulfur dioxide on the rate of ciliary beat in the trachea of rabbit, in vivo and vitro, with studies on the absorptional capacity of the nasal cavity. Internat. J. Air & Water Poll. 4:154-164 (Sept.) 1961.

The writers have studied the effect of acute sulfur dioxide exposure on the ciliary movements in the trachea. Both live rabbits and isolated trachea were used. For the recordings, a previously published method involving, inter alia, the filming of the ciliary movement was used. The experiments in which the animals inhaled the sulfur dioxide show that no certain effect on the ciliary movement could be recorded at concentrations below about 200 ppm. Experiments which involved blowing the sulfur dioxide directly on the trachea in vitro show, however, that about 10 ppm of sulfur dioxide is enough to stop the ciliary movements. This discrepancy can be explained by the absorption by the rabbits' nasal cavities of large quantities of sulfur dioxide. The 2 series of experiments, differing in principle, show clearly that this is the case. About 90-95% of the sulfur dioxide concentrations used (100-300 ppm) were absorbed. - PHEA

650. Dalhamn, T., and Strandberg, L.G.: Synergism between sulfur dioxide and carbon particles. Studies on adsorption and on ciliary movements in the rabbit trachea. Interna. J. Air & Water Poll. 7:517-529 (Aug.) 1963.

The authors found that active carbon can adsorb considerable quantities of sulfur dioxide, even of low concentration, that this does not take place instantly, and that a portion of the adsorbed sulfur dioxide is rapidly converted, even at room temperature, to sulfuric acid. Adsorbed and conconverted sulfur compounds can easily be redissolved in water and consequently also in the moisture of the mucous membranes. The adsorption properties of different types of carbon vary considerably and are not directly dependent on the size of the particles.

Experimental animals were exposed to sulfur dioxide and to carbon with a capacity to adsorb sulfur dioxide and convert this to sulfuric acid, both separately and together to study whether synergism could be shown in their effect on ciliary movements in the rabbit trachea. No such effect could be observed. - Authors' Abst.

651. Daniel-Moussard, H. and Quesson, M.: Microchemical study of experimental silicotic granulomas in the rat. III. Ascorbic acid, mucopolisaccharides, and matabolism of the corresponding sulfur. Bull. Soc. Chim. Biol. (Paris) 43:207-214, 1961.

Lesions were produced experimentally in rats by the intra-peritoneal injection of 100 mg. of quartz dust (particles less than 3 μ) in 2 ml. of saline solution. The animals were sacrificed after 2, 4, 8, 16, and 32 days and histochemical studies made of tissues from the lesions. Half of the group of rats had also received labeled sulfur (S^{35}) in the form of sodium sulfate 6 hrs. before they were sacrificed. Studies were made of the evolution of ascorbic acid and mucopolysaccharides, and of the velocity of incorporation of the labeled sulfur into the mucopolysaccharides, parallel to the formation of collagen. Also, the lesions were separated into 2 fractions, 1 soluble and the other insoluble in Ringer's solution. Max. activity of mucopolysaccharide sulfates and highest level of hexosamines, hexuronic acids, and ascorbic acid were observed simultaneously, principally in the soluble fraction. This points to an intense cellular metabolic activity at a time when the amount of synthesized collagen is still small. Afterwards, collagen synthesis becomes more active, whereas the amounts and activity of soluble mucopolysaccharides diminish. - APCA

652. De Nicola, P., Nicrosini, F., Pasotti, C. and Del Favero, A.: Comparative research on the physiopathological picture in prolonged experimental carbon disulfide poisoning and a high-cholesterol diet. I. Study of the lipid fractions in the serum and the aorta. Gior. Gerontol. (Florence) 10:207-220 (March) 1962.

Lipid fractions in both serum and aortic tissue were determined in rabbits during poisoning with carbon disulfide (6 mg./kg./day intramuscularly for 30, 60, or 90 days) and during the feeding of a hypercholesterolic diet (1.5 g. cholesterol daily for 60 or 90 days). Determinations were made of total lipids, glycerides, phosphatides, steroids, and of fractions A, B, B_2, free, combined and esterified betasteroids, according to the method of Monasterio and Berti. In carbon disulfide poisoning the alterations of the lipid fractions were similar to those of experimental hypercholesterolemia, but at a lower degree as far as the values in serum were concerned and slightly lower than those of experimental hypercholesterolemia in the aortic tissue determinations. The most significant difference from the qualitative point of view is represented by the marked diminution of esterified betasteroids in the course of the poisoning with carbon disulfide, in contradistinction to the marked increase of the same fraction in experimental cholesterolemia. The etio-pathogenetic interrelationships between the alterations of the lipid metabolism in sulfocarbonism and those of arteriosclerosis are discussed on the basis of the results obtained and the data of the literature. - APCA

653. Erban, L. and Korinek, J.: Contribution to the action of SO_2 on the organism. Cesk. hyg. (Prague) 5:121-127, 1960.

The present paper is concerned with investigations of changes in the reactivity of the organism during the chronic action of small doses of sulfur dioxide by means of immunological methods. For this purpose it was necessary, in the first place, to solve the problem of continual dosage of sulfur dioxide by devising an air-proof chamber for the laboratory animals. The experiments were done on 20 male rabbits. Half of the number were exposed to the action of sulfur dioxide and the second half served as controls. The first group of animals inhaled a mixture of air and SO_2, the latter having an average concentration of 36 mg./m.^{3}. The exposure lasted for 9 1/2 hours during an uninterrupted period of 80 days. As criterion of reactivity of the organism the formation of antibodies in response to the administration of a foreign protein was used. The titer of antibodies was assessed according to Ouchterlon's precipitation. In addition, immunoelectrophoresis of the serum was carried out according to Grabar's method. The experiments suggest that even low concentrations of SO_2 (36 mg./m.^{3}) reduce the antibody formation in rabbits. - APCA

654. Erban, L.: Influence of long-term action of low SO_2 concentrations on the protein spectrum of the blood serum in rabbits. Cesk. hyg. (Prague) 6:555-559, 1961.

The paper is concerned with the influence of low concentrations of SO_2 on the blood protein spectrum of rabbits. The experimental animals were exposed to an atmosphere containing 36 mg. SO_2/m.^{3} for 80 days with a daily exposure of 9 1/2 hours. In the experimental as well as the control animals the total proteins and the protein spectrum were determined by paper electrophoresis. The results attained, the rise of globulins (statistically significant at the 1% level) and particularly of a-globulins (significant at the 5% level), and the results obtained by serological methods in previous work, suggest that it is not the direct action of SO_2 but a stereotype response of the organism caused by primary noxious factors. - APCA

655. Erban, L. and Sourek, J.: The effects of the long-term influence of small concentrations of SO_2 on the agglutination titer in guinea pigs. Cesk. hyg. (Prague) 7:417-421, 1962.

This paper is a continuation of a previous work in which only human blood serum was used for immunization. Now immunization has been induced by the use of whole blood. A group of experimental animals was exposed to the effect of SO_2 (average concentration of 18 mg./m.^{3} of air) for 10 hrs. daily for 4 months. During this time all animals were immunized 2 times with human serum in an interval of 2 weeks and, simultaneously, every other day with whole blood. A considerable difference was found in the fall of antibody production, e.g., of precipitins (at a 1% level of significance) as well as agglutinins (at a 5% level of significance). Obvious changes occurred neither in the number of lines of anti-B or anti- globulins nor in the liter of precipitin according to Ouchterlong (which is generally a less sensitive indicator) and this may be explained by partial desensitization called forth by application of whole blood. - APCA

656. Erban, L.: Influence of the prolonged action of small concentrations of SO_2 on the immunoreaction of guinea pigs. Cesk. hyg. (Prague) 7:588-594 (Dec.) 1962.

The author investigated in two groups of experimental animals (female guinea pigs) the influence of the chronic action of small doses of SO_2 with an average daily concentration of 36 mg./m.^{3} of air for 88 days and 18 mg. for 136 days. The animals were exposed to this concentration for ten hours a day. As an indicator of the antibody response of the animals of both experimental groups, the assessment of the precipitation titer of serum according to Ouchterly and immuno-electrophoresis according to Grabar and Williams was used. In both instances a marked decrease of antibody formation (precipitins) was found. For some indicators the difference was at the 1% level of significance. - APCA

657. Fairchild, E.J. and Stokinger, H.E.: Toxicologic studies on organic sulfur compounds. L. Acute toxicity of some aliphatic and aromatic thiols (Mercaptans). Am. Indust. Hyg. A. J. 19:171-189 (June) 1958.

Toxicity data are reported for seven aliphatic and two aromatic thiols administered intraperitoneally and orally to rats in single acute doses, by single 4-hour inhalation exposures to both rats and mice, and by eye instillation in rabbits. In addition, two compounds were administered percutaneously to rats and rabbits.

Compounds tested, and listed in order of decreasing toxicity were benzene-, methyl heptane-, alpha-toluene-, ethane-, hexane-, butane-, propane-, 2-methyl- 1-2-propane-, and 2-methyl-1-propane-thiol, were rated as practically nontoxic, whereas the remainder ranged from moderately toxic to slightly toxic. Thiols had the common toxicologic property of being soporific, the degree ranging from mild stupor to heavy sedation. Methyl heptanethiol was an exception, producing a powerful CNS stimulatory effect. Relatively deep sedation was produced by maximal, sublethal doses of ethane-, propane-, butane-, and hexanethiol. Certain thiols produced a high incidence of latent mortality. The associated responses of thiol toxicity varies according to the route of administration. Significant amounts of thiols were eliminated in the expired air of animals dosed by all but the ocular route. Thus, pulmonary elimination of thiols was a factor of importance in determining ultimate toxicity of these materials. Acute thiol poisoning produced a uniform pattern of central depression and respiratory paralysis with death ensuing from respiratory failure. Methyl heptanethiol, on the other hand, was typical of well-known CNS stimulants such as picrotoxin and pentylenetetrazol having an analeptic action on the higher CNS centers and producing motor, respiratory, and vasomotor stimulation in relatively small doses. Methyl heptanethiol was shown to counteract the central depression induced by barbiturates. Antagonistic action was reciprocated in that barbiturates were found to inhibit methyl heptanethiol-induced CNS activity. Methyl heptanethiol also showed antagonism toward the depressant action of other thiols, but was unable to counteract the toxic effects of maximal lethal doses. Toxic sublethal or lethal doses of methyl heptanethiol induced clonic and/or tonic seizures ending like other thiols in central depression, respiratory failure and death.

Repeated intraperitoneal injections, three per week for 3 and 4 weeks of benzene- and methyl heptanethiol, respectively, at approximate 1/3 LD_{50} doses were tolerated by rats; the latter compound, however, produced mild convulsive seizures. Splenic enlargement was the only gross pathologic change produced with consistency. Benzene-thiol produced injury to the cornea and conjunctivae of rabbits and lethal doses of methyl heptanethiol frequently produced petechiae in the lungs. Thiol-exposed rats and mice commonly showed latent pulmonary infection and/or pneumonia. Liver and kidney damage occurred from intraperitoneal inhalation, and particularly oral administration, but at relatively high levels. Inhalation of high levels produced slight to severe irritation of the respiratory tract, the degree dependent on the thiol; benzenethiol was the only compound to produce significant pathologic conditions at lower levels of thiol exposure.

Safety precautions are given for conditions wherein personnel might be exposed by accident to the more toxic thiols and/or their vapors, and measures are suggested for emergency treatment of thiol intoxication. - Authors' Sum.

658. Fairchild, E.J., Murphy, S.D. and Stokinger, H.E.: Protection by sulfur compounds against the air pollutants ozone and nitrogen dioxide. Science 130:861-862 (Oct. 2) 1959.

Two distinct but related pathways of protection against the lethal effects of ozone and nitrogen dioxide are shown by (1) simultaneous inhalation of compounds that furnish -SH or -SS- , or both, and (2) by injection of thiourea derivatives several days prior to exposure to these oxidant gases. The mechanism of (1) is believed similar to that proposed for the action of radiation-protective compounds; that of (2) involves the development of a tolerance initiated by the thiourea against the oxidants. Ozone and nitrogen dioxide are potent respiratory irritants which may be injurious when inhaled, and evidence exists that the concentration of O_3 in urban air is damaging to plants. Nitrogen dioxide, in addition to acting as a pulmonary irritant, acts as a precursor of O_3 in oxidant smogs by photochemical dissociation.

659. Gerin, C.: Experimental contribution to the chemico-toxicological investigation of sulfur dioxide. Arch. Antropol. crim. 54:413, 1934.

This paper on in vitro and in vivo studies to determine methods for finding evidence of sulfur dioxide poisoning at necropsy discusses the various methods for testing for sulfur dioxide in vitro and the changes that sulfur dioxide may undergo. Sulfur dioxide, for example, may form sulfuric acid, or it may combine with hydrogen sulfide to form free sulfur or water. Hydrogen sulfide is apparently formed as a product of putrefaction after death. Since sulfur dioxide is a gas, it is readily eliminated from the body. It changes to sulfuric acid in contact with the oxygen of the blood and the moisture of skin membrane.

The problem then was to determine actual sulfur dioxide poisoning and eliminate the possibility of getting positive results due to release of sulfur from protein breakdown or poisoning due to sulfuric acid or hydrogen sulfide. Since there is also a danger in confusing hydrogen sulfide and sulfur dioxide, the author removed hydrogen sulfide with lead acetate. Alkaline carbonate is added to transform organic compounds of sulfur dioxide into soluble alkaline sulfites. For positive results, immediate post mortem study is required in chronic poisoning. In acute poisoning the investigation is positive only if made within 48 hours after the death. - BAAP

660. Gilman, J.P.W.: Metal carcinogenesis. II. A study on the carcinogenic activity of cobalt, copper, iron, and nickel compounds. Cancer Res. 22:158-162 (Feb.) 1962.

Nickel sulfide, nickel oxide, cobalt sulfide, and cobalt oxide were shown to be carcinogenic on single intramuscular injection in rats. The sulfide of each metal induced a significantly higher tumor incidence than did its oxide. Comparisons between average latent periods and between measures of tumor progression also indicated that the presence of sulfide enhances the carcinogenic activity of these compounds. Nickel sulfate, iron and copper sulfides, and oxides failed to induce tumors in rats under these conditions. Both C3H and Swiss mice developed tumors from single intramuscular exposure to Ni_3S_2 and to NiO; however, no tumors were induced with CoO in these species. Tumor response in mice was consistently lower than in rats, and no apparent enhancing effect of the sulfide was evidenced. It was concluded that nickel sulfide was probably the compound responsible for the carcinogenic activity of the sample of metallurgical dust originally investigated. - APCA

661. Goetz, A., and Tsuneishi, N.: A bacteriological irritation analogue for aerosols. A.M.A. Arch. Indust. Health 20:167-180 (Aug.) 1959.

The bacteriological irritation analogue (BIA) test - as developed at present - is able to indicate qualitatively and to some extent quantitatively the irritation intensity of aerosols (smog, tobacco, smoke, HCHO aerosols): It has been used in synthetic aerosols as indicator for the degree of association of the irritant gas (formaldehyde) with air-borne particulate matter by comparative tests prior to and after passage through the aerosol spectrometer.

The findings support the assumption that a fraction of the irritant gas molecules associates with the particle surface and that this association produces an intensifying (synergistic) effect, which increases with the aerosol concentration.

The synergistic effect parallels the pattern of Amdur's tests with guinea pigs, and apparently also those of LaBelle with regard to paraffin aerosols in analogy with latex dispersions.

662. Gottschalk, R.G., and Beers, H.N.: Selective toxicity of radioactive sulfate for mouse cartilage and bone marrow. A.M.A. Arch. Path. 65:298-311 (March) 1958.

Doses of 0.001 to 5 mc. per gram S^{35} sulfate were injected into young adult mice. The effects on body weight, food and water intake, blood cells, and varied tissues were studied. The highest doses produce death from destruction of the hematopoietic tissues. After 0.5 and 1 mc. per gram the epiphysial cartilage plates are selectively and irreversibly destroyed and only temporary leukopenia occurs. These toxic effects are related to the metabolic affinities of S^{35} sulfate. They might warrant attempts at therapy with S^{35} sulfate in cases of terminal widespread chondrosarcomas. - Authors' Sum.

663. Greenwald, I.: Effects of inhalation of low concentrations of sulfur dioxide upon man and other mammals. A.M.A. Arch. Indust. Hyg. & Occupat. Med. 10:455-475, 1954.

A review of the literature on the effects of the inhalation of low concentrations of sulfur dioxide and of sulfuric acid upon man and mammals may be summarized as follows.

The various species differ greatly in susceptibility, rats being the most resistant and guinea pigs the least. Man is much more sensitive than is the guinea pig.

Young guinea pigs are much more sensitive to mists of sulfuric acid than are mature animals (one and one-half years).

The therapeutic use of sulfur dioxide, particularly in the treatment of diseases of the skin, in man and in animals has been recalled.

Continued exposure of animals to high concentrations (100 and 500 ppm) of sulfur dioxide lowered their resistance to infection with a variety of micro-organisms and lessened the formation of antibodies. Similar exposures to 50 ppm had no such effect.

Concentrations of sulfur dioxide at 1 ppm and of sulfuric acid at 0.5 mg./m.^{3} are not detected by human beings but do alter the respiratory pattern.

Very few healthy adults find concentrations of sulfur dioxide up to 5 ppm or of sulfuric acid at about 1 mg./m.^{3} objectionable. Concentrations twice as great are apt to be irritating.

Reasons are given for regarding as probably excessive for prolonged exposure the present maximum allowable concentration of 10 ppm of sulfur dioxide.

There is no good evidence that either chronic exposure to concentrations below 5 ppm of sulfur dioxide or occasional exposure to higher concentrations, so long as these are not overpowering, have any ill effect upon healthy men.

The possibility that such persons are adversely affected by simply fog should be investigated, if possible. Adequate statistics might be available from Brighton, England.

The possible modifying action of other contaminants, particularly aerosol sand dusts, should be investigated more thoroughly.

Sulfur dioxide and sulfuric acid can neither be held responsible for the Meuse Valley, Donora, and London episodes nor be absolved from at least partial responsibility for them. - Author's Abst.

664. Haggard, H.W.: Action of irritant gases upon the respiratory tract. J. Indust. Hyg. 5:390-398, 1924.

This discussion of the action of irritant gases on the respiratory tract includes the topics of chemical irritation and vital reaction; determination of locus of action; protective reflexes; relative seriousness of injury to different levels of the respiratory tract and the chronic effects. The relation between the physical properties of irritants and their site of action in the respiratory tract and subsequent symptomatology is tabulated for NH_3, HC_1, HCHO, H_2SO_4, SO_2, Br_2, Cl_2, phosgene and N perioxide. - Author's Sum.

665. Heyssel, R.M., Balchum, O.J., Coles, Z.A. Jr., Ball, C.O.T., and Meneely, G. R.: Survival of rats chronically exposed to sulfur dioxide. Syllabus for the Third Air Pollution Research Seminar, New Orleans, La., March 22-24, 1960. USDHEW, PHS, Div. Air Pollution, Washington, D. C.

Male Sprague-Dawley rats are maintained in constant temperature humidity controlled exposure chambers chronically breathing 0, 1, 2, 4, 8, 16 and 32 ppm SO_2. The rats are transferred daily to clean, serviced cage racks, are carefully examined and weighed weekly with hematologic studies quarterly and pathologic studies at death. Incidence and degree of wheezing, eye opacities, loss of fur and scaley tails are associated with sulfur dioxide concentrations. The control group maintains the best weight. White blood cell counts, per cent neutrophils and hemoglobin are elevated in the SO_2 exposed groups. Per cent survival was significantly lower in 32 ppm rats after 4 months exposure. After 8 months, all of the control group 92% of the 1-16 ppm groups and 75% of the 32 ppm groups were alive. At 12 and 13 months the corresponding per cent survivals are 91, 86 control; 83, 79 1-16 ppm SO_2, and 49, 41 32 ppm SO_2. - Authors' Abst.

666. Khajezadeh, H.: The experimental approach to the study of air pollution as a factor in the etiology of bronchial asthma. Proc. Inst. Med. Chicago 24:117 (July) 1962.

This is an abstract of a paper presented at the Regular Meeting, Feb. 19, 1962, of the Chicago Society of Allergy. Current studies are being undertaken to examine the question of whether long-term exposure of guinea pigs to concentrations of sulfur dioxide which do not, per se, produce demonstrable injury, will alter the response of animals to the inhalation of histamine, serotonin, and antigen in solution or suspension. Results to date, indicate that long-term exposure to SO_2 tends to enhance the response of guinea pigs to inhaled histamine, but fails to alter their response to either serotonin or antigen. The quantitative aspects of the problem are under investigation. - APCA

667. Knobloch, K.: The influence of vitamin C on the course of carbon disulfide intoxication in experimental animals (guinea pigs). Med. Pracy (Lódź) 9:21-32, 1958.

The experiment was carried out on 20 male guinea pigs weighing 450-750 g. The animals were exposed during a period of 16 weeks (5 days a week, 5 hrs. daily) to the action of carbon disulfide vapor (0.17 mg./l.). Ten of the guinea pigs received 3 mg. of vitamin C daily, the rest, 10 mg. Following autopsy it was stated that carbon disulfide, as well as the small amount of vitamin C (3 mg.), had a negative influence on the general state of the animal and caused changes in the internal organs. The histopathological and biochemical changes in the liver, brain, cerebellum, spleen, kidneys, and testicles, were observed. The vitamin C deficiency exerted a decrease of the tolerance to the action of carbon disulfide. However, the prophylactic action of greater amounts of vitamin C in the experimental intoxication with carbon disulfide, was not observed. - APCA

668. Kraut, H.: Physiological-chemical effect of exhaust gases. Jahrb. brennkrafttechn. Ges. 20:7-16, 1939.

The physiological effect of motor exhaust gases is attributed mainly to the action of CO. The saturation of the blood hemoglobin with CO is given for the following concentrations (CO given in volume %): 0.01 - 12%, 0.02 - 22% and 0.04 - 36%. The saturation times decrease with increasing exertion. On inhalation of 0.03% of CO, an 18% saturation of the Hb is reached: during strenuous exercise, within 25 min., at rest, within 80 min. Description of various types of exposure to CO illustrates that a moderate charge of the Hb with CO, which does not produce acute symptoms, may noticeably reduce the exposed individual's capacity for physical exertion. The degree of dilution of car exhausts was studied in a 3-hr. test drive through a narrow valley in the Harz mountains, in which 10 cars were used. The average CO content of the exhaust gases was (given in volume %) 4.0%, that of the surrounding air within 12 m. distance - 0.01 during driving and 0.026 during idling.

The question of chronic poisoning due to other constituents of exhaust gases has not yet been answered, but such poisoning is not likely to occur, as is shown in the cases of exhausts from fuel containing MeOH. The physiological action of exhaust gases from diesel motors was studied in animal experiments. a) Dogs, mice, pigs and rabbits were exposed to aerosols of heavy oils. No weights of the animals, exposure times or droplet sizes are given. The pigs and rabbits proved most sensitive. b) The exposure of pigs and rabbits to exhaust gases from diesel motors caused occasional irritations, due to an SO_2 content of 0.4 mg./l. of air. Concentrations of 0.1-0.3 SO_2/l. of air cause severe irritations in the exposed persons, that of 0.05 mg./l. affects the eyes. The author discusses injury to the lungs from the deposition of soot. Samples of soot, collected by means of ionizing electrodes contained an average of 1.0-2.0% of the unburned heavy oil, the average particle size being $<1\mu$. The soot samples from exhausts of diesel fuel containing 0.2% S were found to have an S content of 4.0%. - KB

669. LaBelle, C.W., Long, J.E. and Christofano, E.E.: Synergistic effects of aerosols. A.M.A. Arch. Indust. Health 11:297-304, 1955.

When aerosols are added to atmospheres containing formaldehyde vapors, the typical effect is to increase the toxicity. Aerosols added to nitric acid fumes tend to decrease the toxicity, while the addition of aerosols to acrolein vapors has a variable or no effect on toxicity. The penetration of gases through the nose ranges from a fraction of 1% for a gas like HCl to 100% for nitrogen. The penetration of aerosols ranges from about 20% for 5 μ particles to 100% for 1 μ particles. The effect of aerosols in altering the toxicity of irritant gases is closely and directly related to the relative penetration of particles and vapor molecules present. When the aerosol penetration exceeds vapor penetration, toxicity is increased; when vapor penetration exceeds particle penetration, toxicity is decreased. These are necessary but not sufficient conditions; there must be a physical combination between vapor and aerosol (absorption, adsorption, solution), or no change will occur at all. - Authors' Abst.

670. LaBelle, C.W. and Brieger, H.: Synergistic effects of aerosols. II. Effects on rate of clearance from the lung. A.M.A. Arch. Indust Health 20:100-105 (Aug.) 1959.

The rates at which inhaled foreign particulates are eliminated from the lung after exposure differ widely, the extreme values for the half-life in the lung being one hour for metallic iron particles and five and one-quarter months for beryllium sulfate. A part but not all of this variation is associated with differences in particle size, large particles, in general, being expelled more rapidly than small particles. Particulates reaching the lung in very small amounts may be retained in the lung for unexpectedly long periods. This would likely be true of the particulates present in the general atmosphere as a result of smog or fallout. Predictions as to the effect of smog or fallout which are based on analogies with industrial experience may be misleading, since industrial dust levels are commonly adequate to stimulate elimination by phagocyte production. The simultaneous administration of inert dust can accelerate the expulsion of biologically active particles from the lung when the latter are present in very small amounts. The greater lung burden increases the release of phagocytes. Accidental exposures to highly noxious particulates (e.g. radium sulfate aerosol) have occurred in the past and doubtless will occur in the futures. More or less effective decontamination procedures have been developed both for internal and for external depots with the exception of the lung itself, where the hazard of such deposition is perhaps the greatest. It is at least conceivable that the synergistic stimulation of phagocytes by inert particles might permit therapeutic decontamination of the lung. - Authors' Abst.

671. Lehmann, K.B.: Experimental studies on the influence of technically and hygienically important gases and vapors. VI. Sulfurous acid. Arch. Hyg. 18:180-191, 1893.

The investigation reported here was carried out in a plant producing sulfite pulp by cooking of coniferous wood with $CaSO_3$ in aqueous H_2SO_3: 24 g. "free" H_2SO_3, 12 g. CaH_2SO_3/1. H_2O, the cooking time being 18 hr. The digester was 20 m. high, and windows and doors provided the only ventilation. The following temperatures were measured (C.): outside, -4°, 1st floor, 8-9°, 2nd floor, 25-29° and 3rd floor, 3-4°. Considerable emittance of SO_2, due to leakage, was noticeable throughout. Analysis of air samples, collected on 2 occasions with a time interval of 16 da., by the $Na_2S_2O_3$ method, gave the following maximum values of SO_2 (in volume %) for floors 1 and 3: (a) 1 - 0.0142, 3 - 0.0367; (b) 1 - 0.0315 and 3 - 0.022. No workers were exposed for prolonged periods of time on the 2nd floor. The following effects on the various concentrations of SO_2 on the author and 2 other persons not accustomed to the exposure to SO_2 are described (SO_2 in volume %): 0.0065 - 0.0115, barely noticeable for the 10-15 min., 0.014 - 0.0147, distinctly noticeable, producing no effects for ½ hr., 0.022, distinctly noticeable but tolerable and 0.0304, severely irritating to the nasopharyngeal mucosae within a few min., the effects diminishing after 10 min. (total exposure was 15 min.). No irritation of the eyes was noticed, no sequelae remained. For workers accustomed to the exposure to SO_2, concentrations of 0.03-0.04 were noticeable but tolerable and without irritating effects. 30-40 workers from both day and night shifts, ranging in age from 20 to 51, in duration of exposure from ½ to 8 yr., were examined. No complaints about or clinical signs of chronic effects on the following organs were found: respiratory system, eyes, gastrointestinal tract and teeth. No other changes attributable to the exposure under normal conditions were detected; however, there were some incidents of accidental exposure to high concentrations of SO_2, due to sudden leakage, which had resulted in burns, corrosions and pneumonia or bronchitis. The author's recommendations were confined mainly to suggestions with regard to improvements in ventilation. - KB

672. Lehmann, K.B.: Recent studies on the quantitative absorption of some poisonous gases by the various parts of the respiratory tract in animal and man. Ammonia, hydrochloric acid, sulfurous acid, acetic acid, carbon disulfide. Arch. Hyg. 67:57-98, 1908.

The following methods were employed in the study of the absorption of inhaled gases in human subjects, cats and rabbits: (1) aspiration method: simultaneous collection of both inspired and expired air in inhalation chamber, (2) bottle method: nasal inspiration from one bottle, oral expiration into the other, (3) wash bottle method: inspiration from one wash bottle, filled with aqueous solution of the known gas, expiration into the other, filled with absorbent (inspiration as follows: a. by mouth into lung; b. nasally into lung; c. sucking in by mouth and blowing out by mouth, as in smoking), and (4) method using Müller's valves (for animal experiments only): similar to (3), the valves being used to control the connection between respiratory tract and wash bottles (inhalation through either tracheal cannula or tubes inserted into the nose). The following summarizes the information given on the gases inhaled, their concentration, inhalation times and methods, as well as % and location of absorption, in that sequence.
A. Experiments with human subjects. NH_3, at 0.1-0.3 N throughout, 20 min., method 3c: 79-87.8% absorbed, of which 63% were found in the sputum, the rest in the oral cavity; 5-10 min., method 3a: 91% absorbed, in sputum 70%, rest in oral and pharyngeal mucosae; 20 min., method 3b: 100% absorbed, in sputum <6%, the rest in nasal mucosa. HCl, 0.29 mg./l., 20 min., method (2): 96% absorbed; 0.36 mg./l, 5 min., 89% absorbed. SO_2, 0.33 and 0.68 mg./l., 30 min., method (1): 70 and 65% resp. absorbed. CH_3COOH, 2.0-3.0 mg./l., 3 min., method (1): apparently 100% absorbed. CS_2, 1.58-2.06, no time given, method (2), modified: 18.8-32.2% absorbed.
B. Animal experiments. NH_3, 0.1 N, 10-15 min., intratracheally (i.t.), 56% retained in lungs. HCl, 0.34-17.8 mg./l., 15-60 min., i.t. and intranasally (i.n.), 60-75% absorbed. SO_2, 1.09-16.7 mg./l., 15-30 min., i.t. and i.n., 46% absorbed. CH_3COOH, 7.9-87.7 mg./l., 30 min., i.t. and i.n., 70% absorbed. CS_2, 32.72-620.38 mg./l., 60 min., i.t. and i.n., 20.6% av. absorbed.

It is concluded: NH_3, depending on concentration and duration, even short exposures, e.g., occupational, may lead to an absorption of 75-100%. HCl, nasal inspiration by animals of up to 12.0 mg./l. air does not cause acid reaction in the trachea; no severe lung changes are observed. Absorption of low concentrations by humans is greater than that by animals. SO_2: animals show pulmonary edema, hemorrhages, occasionally emphysema; human subjects demonstrate severe eye and nasal irritation. One subject tolerated 0.38-0.68 mg./l. for ½ hr. CH_3COOH: the gas affected animals less than did HCl: tracheal hyperemia and occasional emphysema were observed; exposed persons showed mainly irritation. CS_2 caused slight bronchitis and rhinitis in exposed persons. As to the effects of inhalation of acid fumes in general, it is stated that both larynx and trachea proved well protected against effects of nasal inhalation. There was no difference in amounts absorbed between nasal and tracheal inhalation. The test methods employed did not warrant any definite conclusions as to absorption by the lungs. - KB

673. Liese, W.: The toxicity of trichloroacetonitrile and sulfur dioxide. Z. Hyg. Zool. Schädlingsbekämpf. 33:1-4, 1941.

In comparative inhalation experiments, mice were exposed to various concentrations of both SO_2 and trichloroacetonitrile (Tritox), 2 insecticides used for indoor fumigation. In 11 experiments, groups of 5 mice each were exposed for 15-60 min. to a mixed gas stream containing one of the 2 gases in concentrations that were continually controlled and determined by the following determination methods: for SO_2, with sodium thiosulfate; for Tritox, with Kjeldahl's method of N determination. Ranges (r) and medians (m) of the experimental gas concentrations, given as g./m.^{3} air, are: for SO_2, r: 0.76-7.5, m: 2.14; for Tritox, r: 2.9-27.0, m: 8.4. The reason for increasing the Tritox concentrations during the course of the experiments will be explained by the results. The action of the 2 gases on the organisms of the mice was demonstrated by the following symptoms: SO_2 caused severe irritation of the mucosae, restlessness and irregular respiration. Death of the mice exposed to SO_2 occurred during or shortly after the experiments. The animals inhaling the Tritox gas mixture at first were numb and rather motionless. Later they performed somewhat staggering movements or convulsive jumps and showed accelerated respiration. Some of them recovered fast after the termination of the experiments, several, however, died the following day after first demonstrating signs of considerable improvement. In order to confirm the experimental findings as to the MTD of SO_2 for mice, 3 groups of 10 mice each were kept for 40-200 min. in a gas chamber containing 10 m.^{3} of gas mixtures with SO_2 concentrations of 0.96, 2.3 and 2.9 g./m.^{3}

The results of both series of experiments as to the reaction of the organisms of mice to the various concentrations of both gases may be summarized as follows (concentrations given as g./m.^{3}): Tritox was tolerated by the majority of mice for up to 40 min. at a concentration of 2.9, while at 8.0, no animal survived the same length of time. 1.0 SO_2 or less was tolerated by all mice for 200 min., 2.0 by all for up to 15 min., 2.14 by most mice for 15-40 min., while the concentration of 2.76 was lethal for all mice. Death at this concentration occurred at 15-40 min. Although it was demonstrated during these experiments that mice tolerate higher concentrations of Tritox than of SO_2, it was also shown that the inhalation of Tritox may have serious after effects and can lead to death as late as on the following day after striking temporary improvement. Thus, it is not justified to consider the latter gas less toxic than SO_2. - KB

674. Lobova, E.K.: Effect of los SO_2 concentrations on the organism of animals. In: Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U.S. Depart. of Commerce, Office of Technical Services, Washington, D. C. Abstract in Vol. 6, April 1961, pp. 96-97, Complete paper in Vol. 8, 1963, pp. 79-89.

Experiments were performed with white rats. Exposure of 24 rats for a period of 4 hours to SO_2 concentration of 20 mg/m^3 lowered the activity of spleen tissue dehydrase by 28.6 - 63.7%, as compared with the controls; activity of cholinesterase in the tissues of the spleen, kidneys, blood, brain, and small intestine mucosa was reduced by 29.0 - 41.7%. Exposure of white rats to SO_2 concentrations of 0.48 mg/m^3 for 4 hours daily over a period of 144 days caused some animals to lose weight, lowered the spleen dehydrase activity by 50 - 56% and the same of the liver, lung, heart, and kidney tissues. Activity of cholinesterase of tissues of the spleen, liver, intestinal mucosa, lungs, heart, and brain were also reduced. No determinations were made for the effect of SO_2 on the blood. There was a tendency to lowered vitamin C content in the kidney, liver tissues and in the intestinal mucosa. At 0.1 mg/m^3 concentration of SO_2 animal exposure for 5 hours daily over 165 days, there was a slight tendency on the part of carbonhydrase to fall below normal activity. Such shifts were of short duration and reversible. Recommendations: complete absorption of SO_2 from flue gases before they are discharged into the atmospheric air, so that the SO_2 concentration in the atmospheric air should not exceed 0.03 mg/m^3 as in the case of H_2S.

675. Mitchell, R.I.: Retention of aerosol particles in the respiratory tract. A review. Am. Rev. Resp. Dis. 82:627-639 (Nov.) 1960.

There is considerable disagreement among the various investigators as to particle retention in the lungs. The two major causes of lack of agreement are failure to use a uniform breathing rate and the use of a mean particle size to describe a test aerosol which has a wide size distribution. Both experimental and theoretical results show a minimum retention in a 0.4-0.6 μ range. All of the data also indicated 90% or more retention of particles greater than 7 μ. In addition to particle size, the next greatest variable affecting retention is breathing rate. The theoretical calculations of Landsahl agree well with the experimental results obtained by his coworkers, except for particles in the 2 μ range. For this size, the theoretical calculations give results that are too high at both breathing rates studied. The use of radioactive NaCl to obtain an approximation of alveolar retention gives an excellent means of measurement for retention in the smaller branches, bronchioles, and alveoli in therapeutic applications of aerosols. To establish definitely the particle size for maximal retention, the experiments should be repeated using a non-hygroscopic carrier. The results of glycerol-water aerosols indicate that the maximum occurs for particles which have an equivalent diameter of 1.5 μ. By assuming that the particles grow until they contain 85% water, the diameter for the maximum would increase only to 2.3 μ. - APCA

676. Mitina, L.A.: The combined effect of small concentrations of nitrogen dioxide and sulfur dioxide gases. Gig. i Sanit. 27:3-8 (Oct.) 1962.

The combined effect of nitrogen dioxide and sulfur dioxide gases was studied in a chronic poisoning experiment, and the features of the effect produced were analyzed. It was determined that a mixture of NO_2 and SO_2 (with NO_2 in a concentration of 0.0057 mg./l. and of SO_2 in that of 0.01 mg./l.) caused a fall in the experimental animal's body weight, a change in the blood picture, and a decrease in the phagocytic activity of leukocytes. When the concentrations used were half as high, changes were noted in the white blood cells together with a fall in the phagocytic activity of leukocytes. The latter was apparently caused by the toxicity of NO_2 in the concentrations used. The combined action of the 2 gases investigated revealed a certain antagonistic effect. - APCA

677. Morrow, P.E.: Some physical and physiological factors controlling the fate of inhaled substances. I. Deposition. Health Phys. (London) 2:366-378 (May) 1960.

There are a variety of experimental approaches to the measurement of dust deposition. The common requirement in all methods is the ability to measure some parameters of the airborne dust before and after it is breathed. To make dust deposition quantitative so that toxicity or retention studies can be pursued, it is necessary to measure, in addition to the parameters mentioned, the amount of dusty air respired. This paper discusses various physical and physiological factors in terms of their effect on aerosol stability, as they are related to the deposition of dusts in the respiratory tract of man. Efforts are made to indicate the nature of the more important factors and the circumstances in which they might be most significant. 54 references. - APCA

678. Moser, P.: Effect of prolonged inhalation of hydrogen sulfide in dogs. Arch. Exptl. Pathol. Pharmakol. 196:446-454, 1940.

Two dogs were exposed for 2 wk., 7 hr./day, to inhalation of 0.001%=0.014 mg. H_2S/l. air. The gas was added to an airflow directed into the inhalation chamber, 8 $m.^3$ in size, and kept in even distribution. No signs of poisoning could be detected in the dogs after the termination of exposure. A slight cough and increased thirst were the only results. The same 2 dogs and 2 additional dogs were exposed for 2 mo., 7 hr./day, to the inhalation of H_2S at concentrations varying between 0.009 and 0.01%=0.13-0.15 mg. H_2S/l. air. The minimum and maximum concentrations measured were 0.006% and 0.015% H_2S, respectively. These symptoms are described as the results of the exposure: during the first days of the experiment, the animals were less lively, frequently yawned and occasionally choked. Following each exposure, they drank abundantly but ate little. This picture was later less pronounced. All dogs developed laryngitis, cough, rhinitis, conjunctivitis and increased lacrimal secretion. During the course of the whole experiment, the symptoms quickly subsided after the dogs were removed from the exposure, so that the animals were completely normal each morning before the new inhalation began. The blood tests showed no changes in the blood that would indicate poisoning. Due to the irritation of the mucosae, there were some slight changes in the number of leucocytes. The weights of the dogs were the same at the beginning and at the end of the experiment, although occasionally some dyspepsia had been noticed. The following conclusions are drawn from the experimental results. The inhalation of H_2S at the given experimental concentrations caused irritations in the respiratory tract of the dogs exposed. Some dogs had occasional gastrointestinal disturbances, which, however, were not severe enough to produce a change in their weights. The picture demonstrated by the experimental animals closely corresponds with the clinical picture usually seen in humans exposed to the inhalation of the gas. The inhaled H_2S is rapidly oxidized in the organism, and there are no accumulations of the gas in the body that could result in chronic poisoning when a certain level is reached. No blood changes are caused; no sulfhemoglobin was found in the blood. It is mentioned that one dog suddenly died a few days after the beginning of the inhalations. Autopsy revealed that it had pulmonary edema, hyperemia of the lungs as well as of all other organs, chronic tracheitis and a soft liver.

Neither an increased sensitivity nor an adaptation to the inhalation of H_2S was demonstrated by the dogs exposed to the inhalation of the gas at the given experimental concentrations. - KB

679. Murphy, S.D., Davis, H.V., and Zaratzian, V.L.: Biochemical effects in rats from irritating air contaminants. J. Toxicol. & Appl. Pharmacol. 6:520-528, 1964.

The effect of inhalation of acrolein vapors on the activity of several enzymes of male rat tissues was investigated. Elevated hepatic alkaline phosphatase activity occurred following continuous 40-hour exposure to acrolein at concentrations as low as 2.1 ppm. Exposure to higher concentrations for shorter periods of time also increased liver AP activity but the effect was not constant with a constant Ct. Inhalation of ozone, nitrogen dioxide, formaldehyde, and sulfur dioxide also increased liver AP activity. It appears that the hepatic AP response is a nonspecific effect and may be a symptom of the alarm-reaction to stress. The results of this investigation suggest that possible extra-pulmonary sites of damage should be considered in studies of the toxicology of inhaled irritants. - Authors' Abst.

680. Navrotsky, V.K.: The effect of small concentrations of sulfur dioxide during chronic poisoning on the immunologic reactivity of rabbits. Gig. i Sanit. 21:21-26 (Aug.) 1959, in: Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U.S. Department of Commerce, Office of Technical Services, Washington, D.C., Vol. 6, April 1961, p. 157.

The author has studied the action of sulfur dioxide in concentrations of 0.018 to 0.022 mg./l. on the immunologic reactivity of rabbits during chronic poisoning. The agglutination titer of rabbits' blood serum after immunization with typhoid vaccine was 4 to 8 times lower than that of the control animals. The duration of high titer of agglutinins in experimental animals was 3 to 4 times shorter as compared with the controls. The titer of the blood complement was not altered by the action of the above concentrations of sulfur dioxide. Similarly no remarkable changes have been noted in the protein fractions of the blood as tested by electrophoresis. Sulfur dioxide poisoning raises the concentration of acetylcholine in the blood and simultaneously increases the activity of cholinesterase. - APCA

681. Navrotsky, V.K.: Immunobiological reactivity as a method of determination of the maximum permissible concentration of harmful chemical substances in the air of closed premises. Gig. i Sanit. 25:29-33 (June) 1960.

The agglutination titer after immunization with typhoid fever vaccine proved to be a very sensitive test for evaluating the reactivity of rabbits during chronic poisoning with small concentrations of carbon monoxide, sulfur dioxide gases, and vapors of aviation benzene. - APCA

682. Ohno, S.: Comparison of toxicity of sulfur dioxide and ammonia. Igaku Kenkyuu 23:1258-1264, 1953.

On the basis of both his own and other investigators' experimental work, the author first discusses acute as well as chronic SO_2 and NH_3 poisoning and then compares the toxicity of both gases by means of the "fatality product" (concentration of the gas in % duration of exposure in min.) per body weight of animal (in kg.). No further details on the experiments are given in the summary. Exposure to SO_2 and NH_3 causes irritations of the mucosae, especially of the eyes; at higher concentrations, bronchitis, hyperemia, hemorrhages, edema, exudation and pneumonia are the characteristic respiratory symptoms produced. In severe cases of poisoning due to both gases, acidosis is frequently observed. Calculation of the "fatality product" for both gases demonstrated that the toxicity of SO_2 is several times stronger than that of NH_3. - KB

683. Pattle, R.E., Burgess, F., and Cullumbine, H.: The effects of a cold environment and of ammonia on the toxicity of sulfuric acid mist to guinea pigs. J. Pathol. & Bacteriol. 72:219-232 (July) 1956.

1. For guinea pigs, of weight 200-250 g. and an 8-hr. exposure at room temperature the median lethal concentration (LC.50) of sulfuric acid in a cloud with a mass median diameter (M.M.D.) about 2.7 μ is 6.8 p.p.m. The estimated concentrations for 5 per cent mortality (LC.5) and 95 per cent mortality (LC.95) are 4.8 p.p.m. and 9.5 p.p.m., respectively.

2. The LC.50 at room temperature of a mist with M.M.D. about 0.8 μ is 14.9 p.p.m. (LC.5-LC.95, 8.4 p.p.m. and 26.6 p.p.m.). The LC.50 near 0°C. was 11.7 p.p.m. (LC.5-LC.95, 7.6 p.p.m. and 17.8 p.p.m. The difference between the LC.50 at room temperature and that in the cold is significant at the 2 per cent level, and is considered to represent a direct action of the cold on the animals.

3. The effect of sulfuric acid mist at a particular concentration on guinea pigs has not been found to depend on previous exposure at a lower concentration.

4. When ammonium carbonate was placed in the chamber, so that there was always an excess of ammonia present, and acid mist was supplied which in the absence of the ammonia would have caused a mortality of more than 50 per cent, there were no fatalities and the animals after the experiment were macroscopically and microscopically normal.

5. It is concluded that if sulfuric acid is the major toxic agent in smog, the smog could be rendered harmless by adding to it sufficient ammonia to neutralize the acid.

6. Extreme cleanliness is therefore necessary in experiments on the toxicity of acid mists to animals. Otherwise enough ammonia can be generated to neutralize a lethal concentration of acid mist.

7. In animals that survive exposure to the mist without dyspnea the pathological changes are slight, even when the exposure has been greater than that required to produce 50 per cent deaths. Animals dying after a short exposure to the mist show grossly distended and emphysematous lungs with no other serious lesion. The cause of death appears to be asphyxia caused by bronchoconstriction and laryngeal spasm.

Animals dying after longer exposures show gross pathological lesions including capillary engorgement and hemorrhage. It is suggested that these are mainly a sequel to the combined effects of anoxia and increased negative intrathoracic pressure caused by bronchoconstriction and laryngeal spasm.

8. Such damage as is caused by exposures which do not give rise to death is repaired only very slowly.

9. The mist has little effect on the nasal mucosa or the trachea: in some animals, it causes scattered discrete hemorrhages in the stomach walls. - Authors' Sum.

684. Pattle, R.E.: Toxic effects with mixtures of sulfur dioxide and smoke with air. Chemical Defense Experimental Establishment (Gt. Britain) Porton Technical Paper No. 525, AD 90-929, ASTIA Tab No. U-107:4, July 1956, and J. Pathol. Bacteriol. (London) 73:411-419 (April) 1957.

1. The "dosage up to death" (CtD) is defined as the dosage received by an animal continuously exposed to a toxic atmosphere up to the time at which it dies.

2. The "dosage to 50% deaths" (CtD50) is defined as the dosage which would be received by the survivors of a large batch of animals, continuously exposed to a toxic atmosphere, by the time 50% of the batch had died.

3. The toxicity of sulfur dioxide in a concentration of about 2,700 mg/m^3 (1,000 p.p.m.) to mice is enhanced by the addition of 100 mg./m^3 of smoke from a kerosene lamp.

4. A similar effect probably exists with guinea pigs.

5. Previous exposure to smoke has some protective effect against sulfur dioxide; the CtD50 for mice previously exposed to about 40 mg/m^3 of smoke for 22 hours was 56% higher than for fresh mice. The protection appears to involve a reduction in the amount of lung oedema produced.

6. Smoke which has been in contact with sulfur dioxide (5,100 mg./m^3, 1,900 p.p.m.) and from whose gaseous environment the sulfur dioxide has been removed with alkali, had no effect on mice different from that of ordinary smoke. Neither caused fatalities when administered over 77 hours at an average concentration of about 50 mg/m^3 (Ct about 230,000 mg. min/m^3), and the histological pictures produced by the smoke were identical in the two experiments.

7. Relatively small differences in toxicity may give rise, in the early stages of an experiment, to apparently much greater differences in mortality. The bearing such a phenomenon would have on the lethality of atmospheric pollution is discussed. - Author's Sum.

685. Pattle, R.E., and Cullumbine, H.: Toxicity of some atmospheric pollutants. British Med. J. 2:913-916 (Oct. 20) 1956.

In a study of potential atmospheric pollutants, the effects on animals of sulfuric acid mist, sulfur dioxide, mixtures of sulfur dioxide and smoke, coal distillates, wood distillates, acrolein, and diesel fumes were studied. The guinea pig is very sensitive to sulfuric acid mist, but otherwise the concentrations of pollutants that produce any effect on animals are very much greater than those found in smogs. The effects of sulfuric acid mist, sulfur dioxide, and a number of aldehydes on human beings were studied. Sulfur dioxide in low concentration causes bronchoconstriction in certain cases; sulfuric acid mist can cause bronchitis symptoms, and is irritant in concentrations below 0.1 ppm. The toxicity of these compounds is annulled by ammonia. Some results obtained during the London smog of January 4-6, 1956, are described. It is concluded that the toxic effects of smog are due to the action of small quantities of pollutants on exceptionally sensitive human beings; the substances concerned are probably, but not certainly, the sulfur compounds. - Authors' Sum.

686. Pattle, R.E., and Burgess, F.: Toxic effects of mixtures of sulfur dioxide and smoke with air. J. Pathol. Bacteriol. 73:411-419, 1957.

Mixtures of sulfur dioxide and smoke have a greater toxic effect on guinea pigs and mice, than the same amount of SO_2 administered alone. This effect is considered to be due to a simple additive protective effect, not to the adsorption of the gas on smoke, with less edema occurring in the lungs of the smoked animals. Smoke which has been exposed to SO_2, and from whose gaseous environment the SO_2 has afterward been removed, produced exactly the same histological appearances in mice as did ordinary smoke. These experiments are evidence against the hypothesis that adsorption of SO_2 on smoke is an important factor in measuring the lethality of fogs to human beings.

687. Prokhorov, IU.D., and Rozov, A.A.: The pathohistological and histochemical changes in the organs of rabbits subjected to a prolonged action of carbon monoxide, sulfur dioxide, and their mixture. Gig. i Sanit. 24:22-26 (June) 1959.

Histological and histochemical changes have been studied in the organs of rabbits subjected for a period of 3 months to poisoning with carbon monoxide at concentrations of 0.2 and 0.4 mg./l., with sulfur dioxide at 0.2 mg./l., and with mixtures of both gases. The author has noted vascular disturbances, dystrophic lesions in the internal organs, a fall in the activity of the succindehydrase (succino-dehydrogenase?) due to the effect of sulfur dioxide and a more pronounced change produced by the same concentration of sulfur dioxide in the presence of carbon monoxide. In the presence of carbon monoxide at a concentration of 0.2 mg./l. the activity of succindehydrase was observed to increase and this could be regarded as a compensatory effect. - APCA

688. Robson, W.E., Irwin, D.A., and King, E.J.: Experimental silicosis: Quartz, sericite and irritating gases. Canadian M. A. J. 31:237-245 (Sept.) 1934.

Exposure of rabbits to dilute irritating gases (NO_2 and SO_2) produced degenerative lesions in the lungs and predisposed to pneumonitis.

Exposure of rabbits to dilute irritating gases combined with sericite dust did not produce fibrotic changes in the lungs in an exposure of forty weeks.

Exposure of rabbits to dilute irritating gases combined with silica dust gave rise in periods of thirteen weeks or more, to an acute pulmonary silicosis, characterized by typical siliceous fibrotic nodules first in the alveoli, secondly, in the lymphatic aggregations, and thirdly, in the lymphatic glands. - Authors' Sum.

689. Salem, H., and Cullumbine, H.: Inhalation toxicities of some aldehydes. Toxicol. & Appl. Pharmacol. 2:183-187, 1960.

A relative inhalation toxicity study of members of a series of aldehydes, both in aerosol and vapor form, has been reported. The toxicities have been reported as mean fatal doses, expressed as milligram-minutes per cubic meter (mg.-min/m^3), and the pathologic changes in the respiratory tissue have been described.

The unsaturated aldehydes were more toxic to guinea pigs, mice, and rabbits than were the saturated aldehydes. An increased chain length decreased the toxicity of the aldehydes. The relative toxicities in decreasing order were found to be acrolein, crotonaldehyde, acetaldehyde, propionaldehyde, isobutyraldehyde, and n-butyraldehyde. n-Valeraldehyde and isovaleraldehyde were relative nontoxic. Formaldehyde did not cause deaths during or immediately following the exposures, but exhibited later lethal effects. - Authors' Abst.

690. Salem, H., and Cullumbine, H.: Kerosene smoke and atmospheric pollutants. Arch. Environ. Health 2:641-647 (June) 1961.

In the air pollution disasters that occurred in London in 1952, Donora in 1948, and the Meuse Valley in 1930, there were more than 4,000 deaths in one week over and above the normally recorded expectation. The elevation in the death rate was considered due to the effect of toxic substances in the atmosphere. Some of these substances have been identified, while others have escaped specific detection. The concentrations of these pollutants found in such fogs are small as compared with concentrations used experimentally to produce acute detectable morbidity or mortality. It was suggested by Cullumbine, that other materials in the atmosphere may potentiate the effects of the known pollutants, or that the individuals affected have been specifically sensitized to these contaminants.

Studies in inhalation toxicity of sulfuric acid, sulfur dioxide, and aldehydes to laboratory animals have shown that a toxicity exists in the range of 8.5×10^3 to 34.2×10^5 milligram-minutes per cubic meter (mg-min/cu.m.) when expressed as concentration times time.

The present study was undertaken to ascertain the influence of kerosene smoke on the effect of sulfuric acid, sulfur dioxide, acetaldehyde, and acrolein. - Authors' Abst.

691. Salem, H., and Aviado, D.M.: Inhalation of sulfur dioxide. Comparative behavior of bronchiolar and pulmonary vascular smooth muscles. Arch. Environ. Health 2:656-662 (June) 1961.

The inhalation of 200 to 850 p.p.m. sulfur dioxide caused the following effects in anesthetized dogs: (a) pulmonary vasoconstriction; (b) bronchoconstriction, preceded and followed by bronchodilation; (c) increase in pulmonary arterial blood pressure; (d) depression of myocardial force of contraction accompanied by brady-cardia; (e) systemic shock. The constriction of the pulmonary veins supplements the bronchiolar muscles and respiratory reflexes in reducing the amount of sulfur dioxide absorbed via the pulmonary circulation and carried to the systemic circulation. - Authors' Abst.

692. Schnurer, L.: Effects of inhalation of smoke from common fuels. Am. J. Pub. Health 27:1010-1022, 1937.

Into each of 4 gas-tight exposure chambers were placed 4 rabbits and 8 rats. 17 da. before the end of the experiment 4 mice were added to each chamber. One of the chambers was used as a control and the other 3 vented with the flue gases from the burning of the same weight of anthracite (nut), coke (domestic) and bituminous coal (ca. 35% slack), respectively. The average concentrations of the constituents in the air-gas mixtures were: for anthracite 20.6% O_2, 0.4% CO_2, 1.91 ppm SO_2 and 312 particles dust/cc.; for coke 20.1% O_2, 0.5% CO_2, 9.12 ppm SO_2 and 370 particles dust/cc; for bituminous coal 20.0% O_2, 06% CO_2, 7.51 ppm SO_2 and 4,410 particles dust/cc. and for control 125 particles/cc. and usual atmospheric concentrations of the gases. The maximum and minimum concentrations are also given. The animals were exposed 23 hr./day for 80 da. and fed a balanced diet. The following are the results as summarized by the author. Considering the weight gain of the control animals as 100%, the anthracite rats gained 105%, the coke animals gained 114%, and the bituminous group 75%; among rabbits, the anthracite gain was 84%, coke 77% and bituminous coal 9%. The % of hemoglobin and the number of red and white blood cells/$mm.^3$ of blood rose consistently in all groups of animals, but this rise was least noticeable in the anthracite rabbits. The most immediate and pronounced blood changes occurred in the direction of leucocytosis, hemoglobin and erythrocytic increase in the animals subjected to bituminous coal. Intermediate deviations were seen in the coke group. Phagocytosis of C pigment in the lungs of the control animals was scarcely seen. It was slight in the animals exposed to anthracite, more obvious in those of the coke chamber and very marked in those subjected to bituminous coal smoke. The greatest number of uncomplicated pneumonias, and the greatest incidence of bronchitis occurred among the animals exposed to the products of combustion of bituminous coal. Not even the faintest suggestion of fibrosis of the lungs was seen in the control animals or those exposed to anthracite or coke. In the lungs of animals exposed to bituminous coal, spindling of C-laden cells--apparently the earliest stage of fibrosis--was noted. It seems likely that soft coal, even when unaccompanied by other dusts, is capable of producing fibrosis if exposure is sufficiently prolonged. It is stated that the results justify further and more complete studies along the same line. - KB

693. Setterstrom, C.: Effects of sulfur dioxide on plants and animals. Indust. Eng. Chem. 32:473 (April) 1940.

In cases where only 0.1 to 0.2 parts per million sulfur dioxide were used on experimental animals, nothing injurious happened because the sulfur deficiences of nutrient supplies were augmented by the atmospheric sulfur dioxide. Factors influencing the effect of sulfur dioxide on plants are: (1) Resistance was greater at 40°F. or below; (2) resistance decreased with increases in relative humidity; (3) ample water supply made them more susceptible; and (4) younger plants were more resistant than older ones. The studies of effects on animals of prolonged exposures to sulfur dioxide are reviewed. - BAAP

694. Smith, R.P., and Gosselin, R.E.: Protective capacity of methemoglobinemia in sulfide poisoning. Fed. Proc. Vol. 22, No. 2 (Abstracts) (March-April) 1963.

It is postulated that the well-known in vitro inhibition of cytochroms oxidase by inorganic sulfide plays a role in its in vivo mammalian lethality. Indirect evidence is contributed through a demonstrated capacity of induced methemglobinemia to delay or prevent death due to sulfide. Either intraperitoneal sodium nitrite (50 and 100 mg/kg) or p-aminopropiophenone (PAPP, 15 mg/kg) given prior to intraperitoneal sodium sulfide (60 mg/kg) significantly reduced mortality in female mice. Intraperitoneal sodium nitrite (75 mg/kg) or PAPP (15 mg/kg) significantly prolonged survival of female mice exposed to 722 ppm hydrogen sulfide. Rabbits and armadillos were also protected. A corollary to the hypothesis is the existence of an intermediary compound formed from methemoglobin and sulfide, namely sulfmethemoglobin. Data derived manometrically supported the observations of Coryell et al. (J. Amer. Chem. Soc. 59:633, 1937) that sulfmethemoglobin formed by treating methemoglobin with sodium sulfide undergoes rapid auto-oxidation. The resulting compound absorbs oxygen and exhibits the absorption spectrum of oxyhemoglobin. - Authors' Abst.

695. Sprague, G.F., Pettengill, A.G. and Stokinger, H.E.: Initial studies of the inhalation toxicity of beryllium sulfate. Federation Proc. 7:257, 1948.

Data from 56 animals representing 6 species were collected to supply information on the toxic effects caused by the inhalation of $BeSO_4 \cdot 4 H_2O$ at a concentration approximating 90 mg. salt/m.^{3}. The animals were exposed 6 hr./day for 2-wk. period in a small inhalation exposure chamber. Mortality, for all species, was 43% of the exposed animals or 20 of 20 mice, 2 of 10 rats and 2 of 7 hamsters. No deaths occurred among the 2 dogs, 3 rabbits and 14 guinea pigs. Weight response data showed that all species save the guinea pig were adversely affected by the exposure. The rat and hamster showed greatest weight depression, losing 11% of their original weight. Clinical chemical values indicated renal impairment and some subsequent regeneration in the rabbits. Much less serious kidney damage and hepatic injury in dogs was indicated from biochemical tests performed on both blood and urine. Hematologic results showed definite upward trends in the leukocytic count during the 2nd week of exposure. External symptoms differed in extent in each species. Thus, ocular opacity developed in the dog, mouse and guinea pig whereas the rat developed rales; other species were unaffected externally. The histologic findings showed the effect of the absorption of $BeSO_4 \cdot 4 H_2O$ through the respiratory tract of the mouse, rabbit and rat to be pulmonary edema. Hepatic injury was observed in mice dying during the 1st 9 da., but not thereafter. Renal changes were found in the rabbit and rat with some regeneration of the tubular epithelium in the former species. Marked species variation, but good conformity within each species, was observed in the response to the inhalation of $BeSO_4 \cdot 4 H_2O$. The sulfate ion was felt to contribute significantly to the toxicity of the Be salt. - Authors' Abst.

695c. Strandberg, L.G.: SO_2 absorption in the respiratory tract. Studies on the absorption in rabbit, its dependence on concentration and breathing phase. Arch. Environ. Health 9:160-166 (Aug.) 1964.

The absorption of SO_2 in the respiratory tract has been studied from approximately 700 ppm to 0.05 ppm and the results are shown in graphs. Some of the exposures at 200 ppm were made with inactive SO_2, and the SO_2 content was determined here conductometrically, in a manner which is described in detail in Dalhamn and Strandberg's work from 1961. (Since no differences could be found through the use of active or inactive SO_2, all the results have been included in one diagram.)

In the case of exposure air with high SO_2 contents, the experiments show an absorption in the respiratory tract of approximately 95% at inspiration and approximately 98% at expiration. In the case of low SO_2 contents, on the other hand, considerably less of the SO_2 supplied was absorbed (corresponding values, approximately 40% and approximately 80%), and the spread increased between the different experiments. The relation between the SO_2 content of the expired and inspired air, however, does not seem to have changed in the same manner. - Author's Sum.

696. Sukhanova, V.A.: The effect of products derived from the processing of sulfurous crude oil upon the functional state of the digestive canal. Gigiena Truda Prf. Zabolevnia 6:7-11, 1962.

The present inquiries were devoted to the study of the chronic action excerted by gaseous products derived from the processing of sulfur-containing crude oil (cracking gas, comprising saturated and unsaturated carbohydrates and 3-6% of hydrogen sulfide) on the state of the gastrointestinal tract of laboratory animals. The hydrogen sulfide concentration in the chamber was as high as 0.05-0.07 mg./l. In rats intoxicated for a period of 4 months a drop of the uropepsin level in the urine, and a reduced intensity of the radioactive methionine incorporated into the pancreatic proteins (following stimulation of secretion with pilocarpine) was produced. In dogs, poisoned for a period of 5 months with cracking gas, the blood amylase remained unchanged, as did the intensity of protein restitution in different sectors of the stomach and intestines of rats which had also been subjected to cracking gas intoxication. - APCA

697. Takagi, K., Masuda, T., Takagi, N., and Koizumi, S.: Effect of administration of amino acids upon the chronic carbon disulphide poisoning of rats. J. Sci. Labour (Tokyo) 39:5-13 (Jan.) 1963.

The effect of feeding of amino acids, as well as of vitamin B_2, upon carbon disulphide poisoning was investigated taking into consideration the affinity between amino acids and carbon disulphide. Forty-eight rats were divided into 8 groups. Two groups each were fed on either (1) a basic diet, or a basic diet combined with (2) an amino acid mixture (35 mg./day/rat), or combined with (3) lysine (50 mg./day/rat), or combined with (4) vitamin B_2 (0.8 mg./day/rat) in addition to the amino acid mixture. One group of the rats on each of the four diets was exposed to CS_2 (300 ppm.) for 3 hours per day. The retardation of increases in body weight in poisoned rats was more conspicuous in the group fed with the amino acid mixtures or with lysine than with the others. The addition of vitamin B_2 to the amino acid mixture seemed to attenuate the unfavorable effect of amino acids. These facts seem to suggest that the ill effects of CS_2 absorption result from the formation of dithiocarbamic acid, which is caused by the reaction between CS_2 and amino acids. No significant difference between groups was found with regard to the urinary excretion of nitrogen, sulphate, and thiocyanate, or of the thiocyanate concentration in the blood. - APCA

698. Thomas, M.D., Hendricks, R.H., Gunn, F.D. and Critchlow, J.: Prolonged exposure of guinea pigs to sulfuric acid aerosol. A.M.A. Arch. Indust. Health 17:70-80 (Jan.) 1958.

Guinea pigs were exposed to coarse, medium, and fine sulfuric acid aerosols in average concentrations up to 4 mg. per cu. m. for periods ranging from 18 to 140 days. Some exposures to fine aerosol averaged 26.5 and 21.2 mg. per cu. m. for 18 to 45 days. No guinea pigs were killed by these treatments, but four accidents occurred in which higher concentrations of aerosol caused the death, within several hours, of 21 of the 45 animals exposed. The tabulated results are based on the microscopic examinations of sections from the respiratory tract of each animal and the appraisal of 45 histological alterations assumed to be the result of experimental procedures. Statistically significant positive changes were found in only eight items in the animals that received the accidental high concentrations, namely, hyperemia, edema, hemorrhage, extent of cellular exudation, predominance of polymorphonuclear leukocytes, fibrinous thrombi in alveolar walls, and excess of desquamated cells in the major and minor bronchi. Similar but smaller effects were observed with the low concentrations. The medium sized aerosol (about 0.9 microns in diameter) was the most active. Eight statistically significant negative changes were also observed. Evidence of irreversible damages to the lungs, such as fibrosis, was not significantly greater in the animals exposed to aerosols than in the control animals. Published data on acid aerosol concentrations in the field are discussed in relation to those used in the present experiments. - Authors' Sum.

699. Thompson, J.R. and Pace, D.M.: The effect of sulfur dioxide upon established cell lines cultivated in vitro. Canad. J. Biochem. & Physiol. 40:207-217, 1962.

Studies have been made on the effects of SO_2 and its salts on strain L, mouse liver, and HeLa cells. Of the cell lines tested, the HeLa cells seemed to be more sensitive to SO_2 and its salts than the cells of mouse origin. Cells cultivated in "biological" medium grow in concentrations of gaseous SO_2 up to 2000 ppm., although somewhat inhibited. Cells subjected to a concentration of 500 ppm in this medium are not affected greatly and their growth is comparable to those cells in control cultures. The addition of various salts of SO_2 (Na_2SO_4, Na_2SO_3, and $NaHSO_3$) in concentrations from 10 to 200 mg % produced responses ranging from complete inhibition of growth (by 200 mg% $NaHSO_3$) to apparent stimulation of growth by some concentrations of Na_2SO_4. Toxicity of these salts was in the order of $NaHSO_3 > Na_2SO_3 > Na_2SO_4$. When cells in vitro are directly exposed to SO_2 in specially designed culture flasks, strain L cells are apparently able to tolerate 5 ppm. SO_2 for five 8-hour exposure intervals, provided a "recovery" period follows each exposure. Certain components of serum seem to play a very important role as protective agents in modifying the effect of gaseous SO_2, possible by combination. - Authors' Abst.

700. Treon, J.F., Dutra, F.R., Cappel, J., Sigmon, H. and Younker, W.: Toxicity of sulfuric acid mist. Arch. Indust. Hyg. & Occupat. Med. 2:716-734, 1950.

Groups of experimental animals, usually of 2 or 3 guinea pigs, 5 mice, 2 rabbits and 2 rats, were exposed, in a cylindrical steel chamber, to air bearing given concentrations of a mist of aqueous H_2SO_4 solution. The size of the mist particles were predominantly (ca. 95%) less than 2µ in diameter. The exposure periods lasted no longer than 7 hr. in 1 day; some continued for several consecutive da. Guinea pigs succumbed after having been exposed for a brief period on 1 occasion to such a mist, the concentration of which was 0.0866 mg./l. air (22.1 ppm). Animals of other species survived after being exposed to this concentration for 2.75 hr., and much higher concentrations were required in order to kill them. When subjected to 0.549 mg./l. (140 ppm) for 3.5 hr., some mice died, but exposure to 0.699 mg./l. (178 ppm) for 7 hr. was necessary to kill rats, while higher concentrations were required to kill rabbits. Deaths occurred almost uniformly when groups of mice, rabbits and rats were exposed to a concentration of 0.383 mg./l. (97.6 ppm) for 7 hr. on each of 5 successive da. After being exposed to a concentration of 0.203 mg./l. (51.7 ppm) for a corresponding period, all mice, rabbits and rats survived. The mortality data for groups of guinea pigs, mice, rats and rabbits have been plotted logarithmically in relation to severity of exposure. Rabbits were about as susceptible to the mist of H_2SO_4 as they were to either HCl or H_2F_2, but guinea pigs were somewhat more susceptible to the former than to the latter. Signs of intoxication included rubbing of noses with forefeet, sneezing, coughing vigorously and labored respiration with gasping. Lesions resulting from the H_2SO_4 exposures included degenerative changes of the epithelium of the respiratory tract, pulmonary hyperemia and edema and, in some instances, focal pulmonary hemorrhages. There were, in addition, areas of both atelectasis and emphysema in the lungs of all animals. - KB

701. Vasil'eva, O.G.: Distribution and elimination of S^{35} in animals after inhalation of labeled sulfuric acid aerosol. In: Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. A Survey. U.S. Depart. of Commerce, Office of Technical Services, Washington, D.C., Vol. 5, Aug. 1960, pp. 130-135.

Sulfuric acid aerosol rapidly penetrated into the blood stream following a single inhalation exposure of animals. The products of sulfuric acid conversion were distributed by the blood into the body organs and tissues, in which they persisted for 10 days or longer. Sulfur-containing products of sulfuric acid conversion were distributed among the organs and tissues in an uneven manner. They were first localized in the lungs, blood, liver and large intestine. During the early days after inhalation exposure, the accumulation of sulfur-containing products progressively increased in the large intestine, the feces and in the urine. Labeled sulfur-containing sulfuric acid conversion products were eliminated through the intestinal tract and through the kidneys. The bone marrow absorbed considerable quantities of sulfur-containing substances. S^{35} persisted in the bone marrow in considerable amounts for several days after a single one hour exposure to $H_2S^{35}O_4$ aerosol inhalation. The data presented in this report point to the possible resorption of sulfuric acid aerosol.

702. Vedder, E.B. and Armstrong, G.C.: The Toxicity of Sulfur Dioxide. War Dept., Chemical Warfare Service, Report E.A.T.R. 149, 1933, 55 pp.

In this report the median lethal concentrations of SO_2 on several experimental animals and the effects of this gas upon animal life and health when breathed in low concentrations over long periods of time were determined. 2 rabbits, 2 guinea pigs, 4 white rats and 10 white mice/experiment were exposed to various concentrations of SO_2, ranging from 100-600 ppm. for 24 hr. 5 white mice/experiment were exposed at various concentrations, up to 500 ppm, for 10, 60 and 360 min. The median lethal concentrations (MLC) and the surely fatal concentrations (SFC) of SO_2 are shown in the following table.

Animals	Exposure	MLC		SFC	
		ppm	mg./l.	ppm	mg./l.
rabbits	24 hr.	255	0.67	385	1.01
guinea pig	24 "	404	1.06	530	1.39
white rat	24 "	404	1.06	480	1.26
white mouse	24 "	130	0.34	200	0.52
" "	10 min.	1350	3.54	1750	4.58
" "	60 min.	610	1.60	850	2.23
" "	360 min.	340	0.89	550	1.44

White mice, rats and rabbits were also exposed for 6 hr./day for 15 days to ca. 25 ppm SO_2. No deaths which could be ascribed to the effects of SO_2 occurred. These same species were also exposed at 6 hr./day for 30 days to ca. 50 ppm SO_2. No deaths occurred among the rats, but did occur among the white mice and rabbits. These experiments were intended to simulate conditions in industrial plants where SO_2 exposure to workmen occurs. The following reactions of the animals in the exposure chamber were noted: blinking, progressive dyspnea, cloudiness of vision (except in the short exposures of the mice) and progressive inactivity. Autopsy findings revealed that the eyes, the cornea in particular, were affected in rabbits, guinea pigs and rats, the lungs in all showed varying degrees of congestion, emphysema, and/or edema and the kidneys and liver in all were normal. 30 white mice, 16 rats, 6 rabbits and 10 guinea pigs/experiment were continuously exposed to low concentrations of SO_2 over long periods of time. The data and results, contained in the following table, shows that concentrations as high as 0.026 mg./l. (10 ppm) were not injurious to animals exposed to it for 90 da.

Concentrations mg./l.	ppm	Duration days	Temp. °F.	Rel. Humidity %	Results
.008	3.05	16	70	40	No deaths and no symptoms
.0092	3.51	77	70	40	No deaths due to SO_2
.0173	6.60	90	70	40	" " " " "
.0262	10.006	90	70	40	" " " " "
.026	10	53	70	60	" " " " "

The foliage of vigorous plants was destroyed by exposure to 6.6 ppm SO_2 for 24 hrs. - KB

703. Wakatsuki, T.: Experimental study on poisoning by carbon disulfide and hydrogen sulfide. Shikoku Acta Med. 15:671-700 (Sept.) 1959.

Several groups of rabbits were subjected to the inhalation of either carbon disulfide (300 ppm), to hydrogen sulfide (100 ppm), or to a mixture of the above concentrations of these two gases, for periods of 30 min. daily for 4 months. The rabbits were studied in detail for a period of four additional months following the termination of the inhalation period. The rabbits subjected to carbon disulfide only showed the slightest amount of change. No abnormal alterations were recognized in the general conditions, body weight, number of erythrocytes and leukocytes, serum calcium and total serum protein. In the serum protein fraction there was a very slight decrease of albumin, increase of β and γ globulin and a decrease in the albumin-globulin ratio. Some slight changes were noted such as oligochromemia, increase in both reticulocytes, and presence of toxic granules; all these changes returned to normal within a short period after the cessation of inhalation. In rabbits subjected to inhalation of hydrogen sulfide alone, the changes were also quite slight, and somewhat similar to those after carbon disulfide alone, and there were no measurable abnormal findings. The slight changes were restored to normal soon after the discontinuation of inhalation. In the rabbits exposed to the inhalation of the mixture of the two gases, abnormal findings were similarly not demonstrable in the serum protein as they had been in the cases of exposure to the individual gases. But the most striking findings noted were an indication that the slight changes noted for each of the gases separately had been increased by this admixture of gases. After the cessation of inhalation, the restoration to normal was slow without a complete restoration being observed. The author warns of this synergistic action when the toxicities of these gases are considered. - APCA

704. Weedon, F.R., Hartzell, A. and Setterstrom, C.: Effects on animals of prolonged exposure to sulfur dioxide. Contrib. Boyce Thompson Inst. 10:281 (April-June) 1939.

Effects on animals of exposure to sulfur dioxide include general visceral congestion, edema of the lungs, at higher concentration, acute dilation of the right heart, gross distention of the stomach with multiple ulcers and hemorrhages at the higher concentration, and distention of the gall bladder. - BAAP

705. Weedon, F.R., Hartzell, A. and Setterstrom, C.: Toxicity of ammonia, chlorine hydrocyanic acid, hydrogen sulfide, sulfur dioxide. V. Animals. Contrib. Boyce Thompson Inst. 11:325 (Oct.-Dec.) 1940.

Houseflies, mice, and rats were exposed to a continuous flow of ammonia, chlorine, hydrocyanic acid, hydrogen sulfide, and sulfur dioxide gases under controlled conditions at concentrations of 16, 63, 250, and 1000 parts per million for periods up to 16 hours. Toxicity curves are presented at various concentrations of the gases. The order of decreasing toxicity for these gases was found to be hydrocyanic acid, hydrogen sulfide, chlorine, sulfur dioxide, and ammonia. With sulfur dioxide, the signs qualitatively resembled those of chlorine. The rats showed edema and hemorrhage in the lungs. Dilation of the heart and moderate dilation of the stomach without ulcers also occurred in the rats exposed to sulfur dioxide. - BAAP

706. Weedon, F.R.: Experimental acute gastric ulcers produced in animals by exposure to sulfur dioxide. New York State J. Med. 42:620-623, 1942.

The occurrence and nature of gastric ulcers in guinea pigs and mice exposed to sulfur dioxide at levels of 10, 25, 35, 100, 150, 300, and 1000 parts per million are described. No effects on the stomach were observed below 65 parts per million. At 65 parts per million one-third of the animals showed acute distention of the stomach on the ninth day, and at 100 parts per million half the animals showed distention on the fourth day, while two gastric perforations occurred. At 300 parts per million most of the animals showed distention and multiple hemorrhagic ulcers on the third day. Perforations were frequent. At 1000 parts per million the ulcers were less frequent and of small size, but the life span was shorter. The gross and microscopic appearance of the lesions is described. - BAAP

707. **Adams, D.F.:** The effects of air pollution on plant life. A.M.A. Arch. Indust. Health 14:229-245 (Sept.) 1956.

Knowledge of the range of foliar expressions of plants exposed to atmospheric pollutants is extremely useful to those engaged in the study of the scope and severity of an air-pollution problem. The wide variations in susceptibility and characteristic response of common species to typical contaminants provide a convenient method for identifying, determining the distribution of, estimating the level of, and providing a collection medium for subsequent chemical analysis for a pollutant. A detailed review of the progress of research on the effects of sulfur dioxide, hydrogen fluoride, and "Los Angeles-type" smog since 1950 is presented (with work published prior to 1950 cited to provide continuity whenever necessary). Fluoride appears to be a cululative phytotoxicant which may move through the plant vascular system to the leaf tip of margin and produce foliar necrosis upon accumulation of a "threshold concentration." Evidence also points toward possible enzymatic inhibition. Sulfur dioxide and smog exposures result in foliar injury only if the rate of tissue absorption exceeds the rate at which the plant can effectively neutralize the toxic agent. Smog, however, can produce growth inhibition without producing visible injury, whereas sulfur dioxide does not produce so-called invisible injury. Reference is made to a catalogue of common weeds according to their characteristic foliar response and susceptibility to a number of pollutants. - APCA

708. **Adams, D.F., Mayhew, D.J., Gnagy, R.M., Richey, E.P., Koppe, R.K., and Allen, I.W.:** Atmospheric pollution in the ponderosa pine blight area, Spokane County, Washington. Indust. Eng. Chem. 44:1356-1365, 1952.

The ponderosa pine trees in the industrialized area north of Spokane, Washington, have exhibited a characteristic reddening of the needles since 1943, known locally as "ponderosa pine blight." The blighted area now embraces approximately 50 sq. mi. and the trees within a 3 sq. mi. area near the center are dead. As a portion of a comprehensive investigation, the concentrations of gaseous F and S compounds in the air during the growing season of 1950 have been determined through operation of 12 air-sampling stations and a mobile air-analysis laboratory. Throughout 2 mo. of observation, concentrations of oxidizable gaseous S compounds in the atmosphere sampled did not exceed 0.10 ppm. Analysis of F, representing gaseous, H_2O-soluble F-containing compounds, are tabulated according to average concentrations in relation to wind direction and air-sampling stations, also according to distance from damage center, and the influence of meteorological and topographic conditions in the area is discussed. The concentration of F was usually less than 5 ppb, but 3 samples showed more than 50 ppb. Analysis of rain H_2O samples obtained during each rainy period throughout Oct. and Nov. 1950 at 82 locations showed that the highest F concentrations fell in the center of damage, whereas many of the highest S concentrations bore no relationship to the location of the 3 major industries near the center of damage. In conclusion it is stated that the atmospheric concentrations of F present did not of themselves establish the minimum concentration of gaseous F compounds in the air required to produce typical F damage. The concentrations of gaseous S compounds were found to be too low to be an independent factor in the pine tree damage. However, the possible synergistic effects of subdamage concentrations of SO_2 in admixture with gaseous F compounds must be thoroughly investigated before any conclusions concerning the possible causes of the pine tree blight can be drawn. - KB

709. Air pollution in Florida. A.M.A. Arch. Indust. Health 12:567 (Nov.) 1955.

At least 6 companies are engaged in the manufacture of sulfuric acid in central Florida. Five are in an area about six miles in length. For a distance of about half a mile around each plant there has been marked destruction of pine trees and slighter damage to other vegetation. There have been many complaints of throat and mucous membrane irritation. At the request of the local county health department, management of these plants was advised of the complaints and informed that studies will be made. Only a few preliminary studies were made.

710. Bleasdale, J.K.: The effect of air pollution on plant growth. In: The Effects of Air Pollution on Living Material. Symposia of Biology, No. 8, The Institute of Biology (London) 1959, pp. 81-87.

Among the situations causing widespread injury to plants, are mentioned: the oxidized hydrocarbons in Los Angeles smog; hydrogen fluoride produced by aluminum works or glazing processes; and sulfur dioxide produced by smelters or smoldering slag heaps. In Britain the most widespread and economically important air pollutant is coal smoke, containing sulfur dioxide, and with which this paper is primarily concerned. The plant environment is affected in three ways by presence of coal smoke: by a reduction in the amount of light available; by alteration of soil conditions; and by contamination of the air by foreign gases. Smoke haze can reduce the light available to the plant for photosynthesis and thereby reduce its growth rate. This is most serious during winter months when light intensities are naturally low and pollution is at its highest. Summer-growing annuals and perennials, and deciduous shrubs and trees, are therefore more suited for growth in such areas than are species which go through the winter in a non-dormant state. Rain falling in or near industrial areas dissolves the predominantly acidic pollution gases from the air and leaches bases from the soil. To counterbalance this, farmers must use heavy applications of lime on the soil. Sulfur dioxide in the air in concentrations of 0.5 ppm will produce leaf scorch in many species. It has been inferred from earlier experimental studies that sulfur dioxide is not a systemic poison. Other authors have concluded that the gas is without effect on growth of plants unless leaf scorch damage occurs. The author found, in earlier work, that the growth of Aberystwyth S23 rye grass was greatly reduced by treatment with the air polluted by coal smoke although no leaf scorch occurred. He postulates in some detail that sulfur dioxide in the air can interfere with the balance of sulfydryl radicals in the cells but that definite experimental proof of the theory is lacking. Another important effect of coal smoke and sulfur dioxide on plants is the increase in the rate of leaf senescence. Most important of all is the great economic loss to farmers. - APCA

711. Bobrov, R.A.: Use of plants as biological indicators of smog in the air of Los Angeles County. Science 121:510-511 (April 8) 1955.

Plants damaged by smog tend to show the following symptoms: (1) discoloration of leaves, with water-logged appearance and small blisters on undersurfaces of leaves, and (2) dehydration of cells lining the substomatal cavities. Unlike symptoms caused by previously studied phytotoxins (SO_2, O_3, HF) smog-damaged leaves show little overall cellular disruption, and the damage is limited to the regions of the substomatal chambers. Annual bluegrass Poa annua is a particularly useful indicator of smog because: (1) it is extremely sensitive to phytotoxins, (2) smog damage shows as marked banding on the leaves, and (3) it is ubiquitous as a weed. Work is now being done to calibrate Poa as a qualitative, as well as quantitative, bioassay material. - APCA

712. Brandt, C.S., and Hölzel, U.(translators) Guderian, R., Van Haut, H., and Stratmann, H.: Problems of the Recognition and Evaluation of the Effects of Gaseous Air Impurities on Vegetation. Technical Report A61-37. RATSEC, USDHEW, Cincinnati, Ohio (Aug.) 1961, 13 pp.

The prevention of damage to vegetation by gaseous air pollutants is only possible by means of limitations on the immissions of these phytotoxicant substances. The limitations of the immissions must be determined in such a manner that their level in the air within the habitat of the plant does not exceed fixed standards (tolerance limits). Following the definition of the distinction between injury and damage and some discussion of diagnostic methods, a relationship is developed between damage and a tolerance limit based upon the immission and the effect of the injuries. This is suggested as a basis for the critical examination of the hazard to vegetation and the evaluation of admissible emissions.

In the preface, the translators note that while this paper is based upon interest in the sulfur dioxide problem, this toxicant is not named. It is implied in the use of the term Rauchschaden (smoke damage) and in the reference to the work of O'Gara and Hill and Thomas. The implication is that this approach is applicable to all gaseous phytotoxic air pollutants. Conversations and correspondence with other German workers would indicate that this view is widely held. The distinction between "injury" and "damage" is not basically unique with these workers but is not usually so emphatically expressed. The semimathematical treatment of the various relations considered by these workers to be involved in the distinction between injury and damage may not find as general an acceptance. But the approach is worthy of consideration and may stimulate further work in this area. A footnote explains that German workers use the term "immission" in reference to the amount of pollutant as it relates to a receptor and the term "emission" in reference to the amount of pollutant as it relates to a source. - APCA

713. Brennan, E., and Daines, R.H.: Investigation of SO_2 effects on rubber trees as a means of forestalling injury to Malayan plantations. J. APCA 14:229-233 (June) 1964.

The Air Pollution Group of the Plant Pathology Department of Rutgers Agricultural College was requested by Esso Research to make a study of the effects of SO_2 concentrations on rubber trees, and to ascertain and evaluate the effect, if any, of the SO_2 emissions from two new petroleum refineries at Port Dickson, Malaya on the rubber tree foliage in the nearby plantations. Rubber trees were subjected to short-and-long term fumigations at increasing SO_2 concentrations in a test fumigation chamber. Comparison of susceptibility of rubber to herbaceous plants indicate rubber to be considerably more resistant than most of the species tested.

714. Cohen, J.B., and Ruston, A.G.: Nature and extent of air pollution by smoke. Nature 81:468 (Oct.) 1909.

The report contains the results of measurement of impurities at 10 stations. Impurities are broken down into quantities of each type of contaminant, such as soot, tar, sand, minerals, sulfur dioxide, chloride and nitrogenous matter. The tarry constituents were considered most harmful to plants, and these were most highly concentrated in the residential districts. The total sulfur was found to be high everywhere, but particularly in manufacturing areas, and the sulfurous acids were considered to give to town fog its choking and irritating effects.

To demonstrate the detrimental effect of sulfuric acid on timothy grass, tests were performed in which the control grass received acid-free water, while experimental plants were watered with ordinary rain water from Leeds and from Garforth. With Leeds water, the grass became yellow to brown, and this water was shown to have a high acid content. In the other plants where acid was absent or negligible (as at Garforth), there were no deleterious effects noted. - BAAP

715. Crowther, C., and Ruston, A.G.: The nature, distribution, and effect upon vegetation of atmospheric impurities in and near an industrial town. J. Agr. Sc. 4:25, 1911.

Investigations and observations (1906-1910) at Manor Farm, Garforth, and Leeds are summarized. The work comprised analyses of rain samples and the effects of certain classes of atmospheric impurities upon vegetation. Rain samples were assessed for their impurities. Atmospheric pollution influences plant life by (a) reducing intensity of sunlight, (b) blocking stomatal openings, and (c) exerting a toxic influence through the sulfide constituents of the air. This influence affects the plant directly or indirectly through the soil.

Controlled experiments with timothy grass demonstrated that acidified water of 16 parts sulfuric acid per 100,000 parts water, used for irrigation, proved fatal to the grass in little over a year. At 32 parts per 100,000 the grass died in six months, and no vegetation was visible the following spring. Other concentrations of lesser amounts were used, and it was observed that in every case the yield steadily decreased with increased acidity of the water. The effects in this respect were cumulative. Concentrations showing this cumulative effect compared with concentrations of acid in rain water falling in industrial areas. The experiments thus were analogous to natural events inasmuch as concentrations of acid in the water were comparable. The cumulative effect upon timothy grass resulted in a product poorer in protein and richer in crude fibre, and thereby less nutritious. - BAAP

716. Cunningham, O.C., and Addington, L.H.: The value for milk production of alfalfa hay injured by sulfur dioxide gas. Proc. 20th Annual Meeting Western Div. Am. Dairy Sc. A., 1934, pp. 39-41.

In the vicinity of industrial plants, especially smelters, vegetation is sometimes subjected to concentrations of SO_2 gas sufficiently great to cause injury. Alfalfa is one of the plants that is the most likely to be affected by the SO_2 gas. This injury consists of a collapse of the leaf tissues; the affected portions presenting a bleached appearance. The injury first occurs at the margin of the leaflet and progresses towards the center of the leaflet between the ribs and the mid rib. The question has been raised by farmers and others in areas where the alfalfa crop is sometimes affected by SO_2 gas as to whether the injury to the leaflets affects the feeding value for milk production of the resulting hay. - Authors' Abst.

717. Dassler, H.G.: Action of sulfur dioxide on different plant components. Wiss. Ztg. Tech. Univ. Dresden 11:567-569, 1962.

The physical and chemical absorption of SO_2 by certain plant components was investigated in order to get more detailed information on the damages caused by industrial smokes. For terpenes (Δ3-carene, α-pinene, limonene) only physical absorption has been found. For terpene- and wax alcohols, chemical absorption could be demonstrated after physical saturation was reached. Analogous to the reaction of CO_2, the chemical absorption of SO_2 by the alcohols could be interpreted as a formation of SO_2 esters. But these postulated esters could not be detected by chemical means nor by infrared spectroscopy. The chemical SO_2 absorption of the mentioned alcohols was exceeded by malonic ester, acetoacetic acid ester, and cyclo-pentanone esters. Purified chlorophyll gave a SO_2 absorption which was even smaller than that of CO_2. The action of SO_2 on peroxidase and glucosidase was studied; 0.01% and 0.1% SO_2 gave complete inhibition. The inhibition of glucosidase has been demonstrated in vivo.

718. Effect of Sulfur Dioxide on Vegetation. Katz, M., editor. Prepared for the Association Comm. on Trail Smelter Smoke of the National Res. Council of Canada, Ottawa, 1939. 447 pp.

This book describes an extensive study made in Canada of the effects of sulfur dioxide on vegetation. The investigation was prompted by the numerous litigations of American farmers near the Trail, British Columbia Smelter, charging that smoke from the smelter spread in varying concentrations into a valley in the United States thus causing undetermined damage to crops and other vegetation. This is a very complete treatise on the subject. Part I describes the results of field studies; sulfur dioxide in the atmosphere of industrial areas, symptoms of injury on forest and crop plants; the sulfur content of trees and shrubs in relation to sulfur dioxide in the atmosphere; sulfate content of soils; sulfate content of water supplies; and, the effect of sulfur dioxide on the diameter increment of conifers. Part II consists of fumigation experiments.

Part I - Field Studies
1. Katz, M., and Lathe, F.E.: Introduction
2. Katz, M.: Sulfur dioxide in the atmosphere of industrial areas.
3. Katz, M., Ledingham, G.A., and McCallum, A.W.: Symptoms of injury on forest and crop plants.
4. Katz, M., and McCallum, A.W.: The sulfur content of trees and shrubs in relation to sulfur dioxide in the atmosphere.
5. Katz, M., Wyatt, F.A., and Atkinson, H.J.: The hydrogen ion concentration, base exchange capacity and sulfate content of soils.
6. Katz, M., Wyatt, F.A., and Atkinson, H.J.: Hydrogen ion concentration and sulfate content of water supplies.
7. Lathe, F.E., and McCallum, A.W.: The effect of sulfur dioxide on the diameter increment of conifers.

Part II - Fumigation Experiments
8. Katz, M., McCallum, A.W., and Ledingham, G.A.: Description of plots and apparatus used in experimental investigations.
9. Katz, M., and McCallum, A.W.: Fumigation experiments on conifers in their natural habitat.
10. Katz, M., and McCallum, A.W.: Fumigation experiments on transplanted conifers.
11. Katz, M., and Ledingham, G.A.: Effect of environmental factors on the susceptibility of barley and alfalfa to sulfur dioxide.
12. Katz, M., and Ledingham, G.A.: The stomatal behavior of fumigated alfalfa.
13. Katz, M., and Ledingham, G.A.: Experiments on yield of barley and alfalfa.
14. Katz, M., and Pasternack, D.S.: Effects of fumigation on some chemical constituents of barley, wheat and alfalfa.
15. Katz, M., Ledingham, G.A., and Harris, A.E.: Carbon dioxide assimilation and respiration of alfalfa under influence of sulfur dioxide.
16. Katz, M., and Lathe, F.E.: Summary. - BAAP-AGC

719. Egle, K.: The analysis of the effect of SO_2 on plants by experiments in vivo and in vitro. Staub 21:51-52 (Feb. 1) 1961.

Explanation of the relationships between SO_2 immission and the reaction of plants requires determination not only of the concentration and duration of the period of sulfur dioxide influence but also those meteorological factors which may be simultaneously concerned in damage to plants. Open-air experiments in the natural location of the plants are being supplemented by experiments with artificial SO_2 gas treatment of plants in closed chambers. The joint evaluation of the results obtained by these different methods makes possible a deeper insight into the causal relationships underlying the damage to the plants. - English Sum.

720. Evans, A.T.: Observations on the effect of sulfur dioxide on native and introduced vegetation. Proc. South Dakota Academy of Sciences 11:27-32, 1926-27.

1. Sulfur dioxide is more effective in causing damage to susceptible vegetation during periods of moisture and high humidity.
2. Many plants are tolerant of quantities of sulfur dioxide which are injurious to other plants.
3. Continuous subjection of a plant over several days to fumes of sulfur dioxide is effective in its destruction. - Author's Sum.

721. Friede, H.M.: Air pollution and trees. Trees S. African 11:10-12 (April-June) 1959.

Trees affected by air pollution can exhibit a variety of symptoms. The 1st evidence of damage may be a reddish tint or a discoloration of the leaves, followed by shrinkage of the tissues and defoliation. Evergreen conifers are especially susceptible to injury by sulfur dioxide. Eucalyptus trees are also reputed to be sensitive to sulfur gases. Mention is made of some old bluegum trees growing, seemingly unharmed, in a highly industrialized section of Johannesburg. Some deciduous trees with smooth bark such as birch, beech, maple, and poplar do not appear to suffer much in a contaminated atmosphere. The London Plain is well adapted to the smoky and grimy areas since it throws off flakes and patches of bark regularly thereby shedding the foreign substances deposited on the truck and keeping the lenticels of the bark open. The smooth and firm leaves are washed clean by rains. A hardy city dweller also is the Gingko biloba, a "living fossil" on the verge of extinction a few centuries ago. It is often suggested that parks and tree belts be established between residential and industrial areas to "filter out" dust and smoke. In Leipzig, Germany, a count of 5000 dust particles/l. of air was found near the railway station, but only 300 particles/l. in a green belt 1000 m. away. A table appended to the article indicates that Johannesburg and Pretoria have an atmosphere which is relatively safe biologically, and one which will generally do little harm to vegetation. In Pretoria (in winter) the SO_2 concentration was 0.14 mg./m.^{3} and the total solids were 590 g./100m.^{2}/month. These figures for 5 different locations in Johannesburg were 0.03, 0.10, 0.13, 1.18, and 0.36 mg./m.^{3} of SO_2 and 113, 843, 473, 976, g. of solids/100 m^2/month (a figure for the 5th location was not given). Similar figures given for London were 0.37-0.51 mg/m^3 for SO_2 and 940 g. solids/100m^2/month (in Lambeth). - APCA

722. Guderian, R.: The methodology of the determination of SO_2 tolerance limits for land and forest crops in the field study in Biersdorf (Sieg). Staub 20:334-337 (Sept. 1) 1960.

In the surroundings of an iron ore roasting plant an experiment was carried out in the open countryside during the years 1957/58 for the purpose of deriving standards (tolerance limits) for rating the emission of sulfur dioxide and assessing its effect on the vegetation. At six experimental stations having comparable natural conditions investigations are being carried out on the relationship between the SO_2-content of the air and the damage effects on the most important agricultural and forestry cultures. The experimental technical problems arising from this task are illustrated in the paper. - English Sum.

723. Haagen-Smit, A.J., Darley, E.F., Zaitlin, M., Hull, H., and Noble, W.: Investigation on injury to plants from air pollution in the Los Angeles area. Plant Physiol. 27:13-34, 1952.

The investigations contained in this paper demonstrate the utility of plants in analyzing air pollutants. They further show for the first time that hydrocarbons, normally harmless air pollutants of organic nature, can cause severe damage through their reaction with substances known to be in the air. In this way these experiments have contributed to a better understanding of the smog problem. - From Authors' Sum.

724. Haywood, J.K.: Injury to vegetation and animal life by smelter waste. USDAB 113, 1910.

This is a report of a study to determine the injurious effects which wastes from plants smelting sulfide copper ores may have on vegetation and animal life. Effects of sulfur dioxide on certain vegetation were first determined experimentally to see if sulfur dioxide was actually injurious and the type of injury it caused. Observations of actual damage were made at and around the Anaconda, Montana, smelter. In the experimental investigation, sulfur trioxide content in foliage was determined and compared with controls, and in all cases the exposed trees contained a higher concentration than the controls. In the field investigation, observations as to general appearance, types of growth, and sulfur trioxide content, were made of foliage about the smelter. These observations were made during the summer of 1908. General conclusions included: (1) From actual chemical analysis it appeared that the forests extending at least 10 miles north, 11½ miles east, 9½ miles south, and 15 miles west, of the smelter were injured. (2) It was noted that the junipers were very resistant to smelter fumes, while the red firs were very susceptible and were badly damaged at distances of from 18 to 19 miles from the smelter; the lodge pole pines were damaged for at least 10 or 11 miles. (3) Large quantities of arsenic were discharged from the smelter and settled on the grass of cattle ranges as far as 15 miles away. Such arsenical grasses are not a suitable feed for cattle. - BAAP

725. Heiling, A.: Investigations on the influence of gaseous atmospheric impurities on plant transpiration, and some pre-investigations on the usual method of transpiration determination. Ztschft. Phytopathol. 5:435-492, 1933.

This article describes methods of transpiration determination, investigations on the influence of sulfuric acid on transpiration, and experiments with punched leaf pieces. The bibliography, consisting of 48 references, covers the German literature from 1872 to 1931.

726. Holmes, J.A., Franklin, E.C., and Gould, R.A.: Effect of sulfur dioxide on vegetation. Report of the Selby Smelter Commission. USBMB 98, 1915.

Several fresh, vigorous plants (arbor vitae, grapevine, peach limb, and apple limb) were exposed experimentally to the action of sulfur dioxide mixture. No appreciable damage was observed except on the grapevine, the leaves of which were bleached. - BAAP

727. Horicht, W,: Forest devastation by smoke. Kranke Pflanze 15:90, 1938.

Sulfur dioxide is the chief offender of smoke against vegetation. The picture of sulfur dioxide poisoning comprises red spots on the leaves, reddening of the needle termini, and lowered respiration. The deposition of soot, while not poisonous, interferes with respiration and excludes light. - BAAP

728. Jones, H.T.: Agriculture and smoke pollution. Gas J. 231:206, 1940.

This paper is a collection of observations made in the course of advisory work in Yorkshire, during the previous 15 years, of the effect of smoke fumes on vegetation. Smoke absorbs solar energy and reduces the assimilating power of the leaves. The sulfur in the smoke becomes oxidized to sulfuric acid, which burns up the plants. Thus vegetation growing near industrial sites in inhibited or stunted in its growth due to the action of sulfur compounds. - BAAP

729. Katz, M.: Sulfur dioxide in the atmosphere and its relation to plant life. Indust. Eng. Chem. 41:2450-2465 (Nov.) 1949.

Sulfur dioxide from industrial gases in low concentrations is widely distributed in the atmosphere. In exposures of sufficient duration to concentrations higher than about 0.40 ppm. it may be toxic to sensitive plants at periods during the growing season when physiological activity is high and the conditions for rapid absorption of this gas by the leaves are at a maximum. Low concentrations, in the range up to 0.10 to 0.20 ppm. have been demonstrated to be without influence on plant life, in the absence of visible markings. There is no effect, in this case, after long-continued exposure on rate of growth, yield of crop, photosynthesis, respiration, or on the daily march of the stomata. The effects may be beneficial if the plants are growing in a sulfur-deficient soil or nutrient. No basis has been found for the theory of invisible injury. Results of the investigations on various aspects of the sulfur dioxide pollution problem have been presented: occurrence of sulfur dioxide in the atmosphere of industrial areas; sulfur content of vegetation; effect on soils; symptoms and diagnosis of injury from sulfur dioxide and other factors; retardation of diam. increment in conifers; experimental studies on the influence of environmental factors on susceptibility, the effects on conifers in natural habitat and transplanted stock, yield of crop plants, stomatal behavior, and photosynthesis and respiration. It is hoped that the methods and results described will serve as a guide in investigations of effects of other industrial waste gases on plant life. - APCA

730. Katz, M., Ledingham, G.A., and McCallum, A.W.: Symptoms of injury on forest and crop plants. Nat. Res. Council (Canada) Pub. No. 815, 1, 1939.

Most damage is done to crops and plants in the early part of the growing season when sulfur dioxide combines with high humidity. Symptoms of acute and chronic injury to plants are described. - BAAP

731. Katz, M., and McCallum, A.W.: The effect of sulfur dioxide on conifers. In: McCabe, L.C. (editor): Air Pollution. Proc. United States Technical Conference on Air Pollution. McGraw-Hill Book Co., Inc., New York, N.Y. 1952, pp. 84-96.

Experimental studies under known environmental conditions and field investigations indicate that sulfur dioxide effects on conifers are governed by the same concentration-duration-absorption factors which apply to the more extensively investigated crop and ornamental plants. There is a limiting concentration of sulfur dioxide below which the trees may be treated indefinitely without injurious effects. The most susceptible period is in the spring and early summer, coincident with the time of the year when the leaves are most active physiologically. The possibility of acute injury occurring during the winter, when temperatures are low and the needles are dormant, is remote. Seedlings are affected by sulfur dioxide more readily than older trees. Two forms of injury may be recognized: acute and chronic. No evidence has been found to support the existence of so-called "invisible injury." When high concentrations were not present, the fumigations were without toxic effects. - Authors' Sum.

732. Katz, M., and Shore, V.C.: Air pollution damage to vegetation. J. APCA 5:1-8 (Nov.) 1955.

The problem of gas damage to vegetation has become increasingly significant in recent years with the continued expansion of industry and growth of population. The principal agents of air pollution damage of economic importance are probably sulfur dioxide, fluorine compounds and "smog gases" of the type encountered in the Los Angeles area. Other gases may be of concern in special cases but their effects are usually limited to the immediate neighborhood of the source. Sulfur dioxide damage to plant life and its mode of action have been studied extensively for many years. The evidence in the present study on chlorophyll and phenophytin conversion in conifer leaves indicates that acid gases such as sulfur dioxide in sufficiently high concentration, convert the chlorophyll pigments into the corresponding pheophytins.

733. Kaut, V., Tusl, M., and Svorcova, S.: Relation between the damage to forests, concentration of SO_2 and climatic factors. Cal. Hyg. 6:30-37, 1961.

Results of a long-term investigation into concentrations of SO_2 in the atmosphere, in the vicinity of a solitary source of exhalation, are presented. Dependence of SO_2 on climatic and ground factors was proved. Data gained by the investigation can serve as a basis for setting-up a desulfurating device. - PHEA

734. Keller, H.: Contribution to the detection of fume damage to conifers provoked by sulfurous acid. Forstwiss. Forsch. No. 10 (Hamburg) 1958, 63 pp.

The 1st part of this study is concerned with the SO_2 content of the air in the vicinity of immission of an air pollution source. A gas-registering apparatus was used which has a very high sensitivity, up to 0.01 mg. $SO_2/m.^3$. The SO_2 content of the air of Munich was determined over a period beginning in May, and extending through the winter. The content was much higher during the winter. At one time during the winter during a period of temperature inversion with a smoke pall hanging over the city, an average of 0.8-1.9 mg. $SO_2/m.^3$ was registered with peaks over 2.5 mg. In 2 Bavarian areas of known fume injury the average was 0.1-1.0 mg. $SO_2/m.^3$ with peaks of 2.5 mg. and higher being registered. As a measure of concentration it is suggested that not only the average SO_2 content of the air but also the time element be considered, such as the value reached for 100 min. daily. The 2nd part of the study was concerned with the influence of SO_2 on the gaseous exchange of forest trees. Using an infrared recorder the photosynthesis, respiration, and transpiration of potted firs, spruce, and pines were recorded both in an SO_2-free environment and in 1 with a concentration of SO_2 of 4-6 mg./$m.^3$. Under the influence of SO_2, the net assimilation rate continually decreased. Respiration and transpiration increased at the beginning of the exposure period. The ratio of photosynthesis to transpiration quickly decreased. As of this date, the recorder gives the earliest indication of damage from SO_2.- APCA

735. Koshi, S., Suzuki, T., Furukawa, G., and Goto, M.: Atmospheric Pollution (III) -- Effects of Sulfu Dioxide from Factory Chimney on Vegetables. Bull. Inst. Pub. Health (Tokyo) 6:5 (Jan.) 1957.

The effects of sulfur dioxide on vegetables were studied in Amagasaki City. It was observed that many vegetables, such as soy beans, wheat, rice plant and sweet potatoes, etc., were affected by injurious emitted matter from factory chimneys at the Minami-Schimizu district in Amagasaki City.

There are two small smelt industrial chimneys in the farm field, and the amounts of sulfur dioxide emitted from these industrial chimneys were about 500 kg per day.

The concentration of sulfur dioxide in the atmosphere near the ground surface was emitted by Sutton's diffusion theory. By this estimation, it was assumed that the maximum surface concentration was seen at the place which is 250-350 meters distant from the source under the neutral meteorological condition, and the concentration at this place was 0.62 p.p.m. From the experimental study on the vegetable damage by Zimmerman and the estimated concentration of sulfur dioxide by Sutton's diffusion theory, the described damage of vegetables may be explained by sulfur dioxide exposure from the factory chimneys. - PHEA

736. Leone, I.A., Brennan, E., and Daines, R.H.: What is in New Jersey air that causes plant damage? New Jersey Agriculture 44:11-44, 1962.

Air samples were taken in Carlstadt, Bordentown and at New Brunswick, and SO_2, O_3 and NO_2 were determined daily during a 4-hr period. With regard to SO_2, Carlstadt was the most polluted, New Brunswick next, and Bordentown had the lowest pollution. In Carlstadt and New Brunswick SO_2 often exceeded 0.1 ppm which is believed to cause damage to alfalfa, violets and crab apple. In all three locations O_3 frequently exceeded the 0.035 ppm which causes fleck on tobacco and other more sensitive plants. NO_2 is a constituent of some of the photochemical reactions which produce material toxic to plants. High barometric pressure and low wind speed are associated with an increased air pollution load.

737. Leone, I.A., Brennan, E., and Daines, R.H.: The relation of meteorological phenomena to concentration of phytotoxic air contaminants in three New Jersey communities. Phytopathology 52:924 (Sept.) 1962.

This is an abstract of a paper presented at the 1961 Meeting of the Northeastern Division of the American Phytopathological Society, of November 2 and 3, 1961.

Sulfur dioxide (SO_2), oxidants, nitrogen dioxide (NO_2), and fluoride were measured daily from September through November, in Carlstadt, Bordentown, and New Brunswick, farming communities where crops were suffering damage from air pollutants. Concentrations of each pollutant fluctuated daily and were highest in Carlstadt, where SO_2 and oxidant content frequently exceeded phytotoxicant levels. In the other 2 areas, SO_2 rarely reached toxic levels, but the oxidant concentration was often sufficient to produce markings on sensitive species. In each locality, NO_2 concentration correlated fairly closely with SO_2 concentration; but has little significance with regard to plant injury *per se* and fluoride content was generally low. Days on which peaks in pollutant concentration occurred were characterized by conditions typical of air stagnation; high barometric pressure, low wind velocity, and low visibility. Pollutant concentration was highest November 14-16, when conditions of air stability were so extreme and so persistent that they met the requirements of the U.S. Health Department in Cincinnati for the sounding of a national air pollution alert. - APCA

738. McCallan, S.E.A., Hartzell, A., and Wilcoxon, F.: Hydrogen sulfide injury to plants. Contrib. Boyce-Thompson Inst. 8:189-197, 1936.

1. The effect of hydrogen sulfide gas on 29 different species of green plants was studied. The plants were fumigated in glass chambers out-of doors during the growing season, the compressed hydrogen sulfide gas being introduced into an air stream which was blown through the chamber.

2. Young rapidly elongating tissue is characteristically more sensitive to hydrogen sulfide injury than older tissue. Typical symptoms are a scorching of the young shoots and leaves, basal and marginal scorching of next older leaves, and mature leaves unaffected. Symptoms are usually fully expressed within a few days of treatment.
3. The different species varies widely in their response: carnation, purslane, Boston fern, apple, cherry, peach, strawberry, and coleus showed no appreciable injury at concentrations below 400 p.p.m.; pepper, rose, nasturtium, castor bean, gladiolus, sunflower, buckwheat, and cornflower, slight to moderate injury at concentrations from 40 to 400 p.p.m.; and soybean. Turkish tobacco, aster, kidney bean, cucumber, tobacco (N. glauca), salvia, poppy, tomato, clover, radish, calliopsis, and cosmos, slight injury below 40 p.p.m. and severe injury and death above 400 p.p.m.
4. Temperature is as important as concentration, injury increasing rapidly with increases in temperature.
5. In some cases wilted plants appear less sensitive to hydrogen sulfide injury than normal turgid plants.
6. Plants tested for lime sulfur injury (aster, buckwheat, sunflower, and tomato) showed symptoms identical with those produced by hydrogen sulfide. - Authors' Sum.

739. Metcalfe, W.: Damage to greenhouse plants caused by town fogs with special reference to sulfur dioxide and light. Ann. Appl. Biol. 28:301 (Nov.) 1941.

Experiments were done with sulfur dioxide and similar atmospheric contaminants. It was found that "plants will endure higher concentrations of sulfur dioxide in a relatively dry, than they will in a humid atmosphere." Effects of sulfur dioxide on plants and effective measures of protection are discussed. - BAAP

740. Nakayama, K.: Air pollution and its effects on plants. J. Japanese Chem. (Tokyo) 16:8-16 (Oct.) 1962.

In this survey of the air pollution effects on plants, emphasis is placed on the gaseous air pollutants including SO_2, HF, hydrocarbons, NO, NO_2, and ozone. The comparative resistance of various plants to injury by air pollution is discussed, as well as some of the manifestations of injury. Hydrocarbons, especially hexene (C_6H_{12}), in their reactions with ozone form intermediate products which appear to be acutely damaging to vegetation. The role played by NO and NO_2, which are mainly released to the air from automotive exhausts, in the chain reaction producing ozone, is discussed. A correlation of the physiological disturbances of plants, such as the weather fleck of tobacco or the stipple disease of grapes, has been related to a high concentration of ozone. Los Angeles smog has been found to contain 0.0 - 0.7 ppm of organic acids of which 60% is formic acid. An apparent proportional increase in formic acid content in plants with the degree of physiological effect of air pollution, has been cited. This is in contrast to other organic acids where the content in plants changes only slightly and irregularly. - APCA

741. Oliver, F.W.: In report on the effects of urban fog on cultivated plants to the scientific committee. Royal Horticul. Soc. 1893.

The various substances found in London urban fogs which have become polluted by smoke are discussed. The sulfuric and sulfurous acids are conceded to be the important noxious elements, although other substances are believed also to have a deleterious effect on plants. These include hydrochloric acid, ammonia, metallic iron, ferric oxide, hydrocarbons, phenol, and some of the members of the pyridine series.

Various types of injuries to plants, such as discoloration and disarticulation of the leaves, are mentioned. The type of damage peculiar to each type of plant is also discussed. The effect of loss of light due to air pollution is discussed as another contributor to plant injury. - BAAP

742. Ruston, A.G.: The plant as an index of smoke pollution. Ann. Appl. Biol. 7:390, 1921.

The variation in susceptibility in various types of plants to smoke damage suggested to the author that carefully selected varieties might be used as indicators of smoke pollution. The conifer is considered the most sensitive plant, while hollyhock is considered the best indicator of smoke pollution. The general appearance of the exposed plants is discussed. The brown splotches and other changes in leaves are considered the best index. Other measurements are annular rings and chemical analysis of sulfur trioxide content in leaves. - BAAP

743. Scheffer, T.C., and Hedgcock, G.G.: Injury to Northwestern Forest Trees by Sulfur Dioxide from Smelters. USDATB 1117, 1955. 49 pp. U.S. Government Printing Office, Washington 25, D.C.

This report deals with studies which were made of 2 timbered areas affected by SO_2 emissions from large ore smelters in the northwest. Injury to trees varied extremely according to age and species and distance from source of pollution. A small percentage of sapling and larger ponderosa pines remained in good condition, indicating protective factors which are not present in most of the trees. Douglas firs did not show this individual resistance. Diameter growth was retarded a few years earlier than height growth. These and other factors are discussed extensively. Eighteen years after the initiation of sulfur dioxide abatement measures in the Columbia valley, there was no evidence of current injury to timber or plants, and no indication of deleterious effects of sulfur accumulations in the soil.

744. Sheehy, J.P., Henderson, J.J., Harding, C.I., and Danis, A.L.: A Pilot Study of Air Pollution in Jacksonville, Florida. PHSP 999-AP-3, USDHEW, PHS, Cincinnati, Ohio, April 1963. 65 pp.

The objectives of the pilot study were to develop a preliminary evaluation of air pollution in Jacksonville and to determine whether the atmospheric concentrations of fluorides and SO_2 were at a level to cause the damages to vegetation which had been reported in the area. The study consisted of an emission inventory, a meteorological investigation, an intensive short-term study of downtown Jacksonville, and an industrial area study. Various programs of air sampling were carried out, including ones for sulfur dioxide, oxidants, nitrogen dioxide, carbon monoxide, hydrogen sulfide, fluorides, and suspended particles. During the study fluoride levels were found to be high enough in certain parts of the city to cause damage to sensitive plants; SO_2 and oxidants were also present at significant levels. Concentrations of SO_2 in 70 samples taken in a downtown park on Aug. 3-10, 1961, ranged from 0.0 to 0.174 ppm., with a mean and median of 0.015 and 0.004 ppm. respectively. During this study 95% of the samples were of less than 0.092 ppm. Although the concentrations of SO_2 observed were generally low, the max. concentration (0.174 ppm.) during this non-heating period can be interpreted as a warning that concentrations could exceed levels that are known to cause damage to susceptible plants, especially during winter months when space heating is necessary. Concentrations of oxidants, recorded in the same study, ranged from 0.000-0.162 ppm. (as hydrogen peroxide), with a mean and median concentration of 0.052 and 0.049 respectively. Of the observations 95% were less than 0.126 ppm. On 5 of the 8 days of the study period, the diurnal pattern of oxidant levels indicated a photochemical type reaction similar to the patterns observed in several other large cities. Results of the study also indicated that pollutants from Jacksonville were being carried across the St. John's River, and finally, that several pollutants constitute a potential problem in the city and should be evaluated further. - APCA

745. Solberg, A., and Adams, D.F.: Histological responses of some plant leaves to hydrogen fluoride and sulfur dioxide. Am. J. Botany 43:755-760 (Dec.) 1956.

Histological responses to HF and SO_2 were indistinguishable. Various postulates are discussed concerning the means and pathways by which a phytotoxic air pollutant may enter the leaf and produce injury. - PHEA

746. Stratmann, H.: The use of air analysis for determining the effect of sulfur dioxide on vegetation. Staub 21:61-64 (Feb.) 1961.

"Maximum Immission Concentrations" (MIC-values) are laid down to limit permissible immissions. They are derived from so-called tolerance limits which are obtained from the relationship between the immission and its harmful effect. In the case of the effects of sulfur dioxide on vegetation it has been shown how the tolerance limits are obtained from the threshold-of irritation function. They are not identical to the MIC-values which can only be derived from them by means of an additional definition. Above all the permanently changing conditions of immission are decisive for this additional definition. This must be taken into account if supervision of the MIC-values is to be made possible by the aid of air analysis. PHEA

747. Sulfur dioxide as plant-growth stimulant. Chem. Tr. J. 154:10 (Jan. 3) 1964.

Sulfur dioxide in the atmosphere is usually regarded as injurious to vegetation. However, results of research sponsored by the Consolidated Mining and Smelting Co. of Canada, at Washington State University, show test traces of SO_2 might actually increase the wheat crop. SO_2 was applied in gas form in glasshouse tests, and liquid SO_2 was injected into the soil in field tests.

748. Swain, R.E.: Smoke and fume investigations - A historical review. Indust. Eng. Chem. 41:2384-2388 (Nov.) 1949.

This review has been limited to a few outstanding cases of injury to animal and plant life by emanations from industrial plants at Ducktown, Tenn., Anaconda, Mont., Salt Lake City, Utah, and Trail, B.C. At Anaconda injury by sulfur dioxide began to appear on the red fir and lodgepole pine. The smelters at Ducktown and in Montana had a daily output of 1000 tons or more of sulfuric acid. In Utah lead and sulfur trioxide fumes were put under control by liming and bag filtration, and by electrical precipitation. Regulations were put into effect and each plant was to discharge its gases through a stack at least 450 ft. in height; give buoyancy to escaping gases by maintaining throughout the growing season for vegetation in that area, between sunrise and sunset, a difference in temperature of at least 75°C between the stack gases and the outside air; and subject all emanations from smelting operations to electrical precipitation by the Cottrell process, bag filtration, or any other process of equal efficiency for the removal of suspended solids and mists. Trail, B.C., experts studied every known process for sulfur dioxide recovery and for making sulfuric acid and ammonia. About $13,000,000 were invested in recovering airborne wastes and converting them to marketable by-products. Phosphate fertilizers of several types, ammonium sulfate, and sulfur were produced on a large scale. The Laboratory for Agricultural Research near Salt Lake City has for over 3 decades studied atmospheric pollution and remedial measures at its company's many plants over the country and has published many papers, covering research in plant fumigation and the development of procedures of the highest accuracy in experimental work in that field. The recorder, developed by Thomas of that group, is now widely employed in sulfur dioxide determinations. This analytical robot makes a determination of sulfur dioxide and records it automatically every 20 min. Later designs record a determination every 10 or 15 sec. and are adapted also to the estimation of total gaseous sulfur compounds in the air. - APCA

749. Thomas, M.D., and Hill, G.R.: Relation of sulfur dioxide in the atmosphere to photosynthesis and respiration of alfalfa. Plant Physiol. 12:309, 1937.

The process of photosynthesis involves delicate and complicated chemical reactions under the influence of light. These reactions are readily affected by external conditions. Fumigation with 7.0 parts per million of sulfur dioxide caused about 95 percent leaf destruction on alfalfa. The plant rapidly oxidizes sulfur dioxide to a sulfate, which is the form in which plants use sulfur for their nutrition. - BAAP

750. Thomas, M.D., Hendricks, R.H., and Hill, G.R.: The sulfur metabolism of plants. Effect of sulfur dioxide on vegetation. Indust. Eng. Chem. 42:2231-2235, 1950.

Sulfur is an essential constituent of the plant proteins. Excess sulfur above that needed for organic compounds is present as sulfate. Organic sulfur values have narrow limits in the different species of plants but sulfate concentrations vary over a wide range depending on the sulfur supply to the plant. Sulfur fractionation and distribution have been studied by means of radiosulfur and paper chromatography. Cystine and methionine account for a large part of organic sulfur in alfalfa leaves. Nitrogen and sulfur nutrition are closely related. Effect of sulfur dioxide absorption in sublethal amounts; mechanism of sulfur dioxide injury; role of environmental factors in controlling absorption of gas by the plants; and effect of leaf destruction on yield are discussed. - Authors' Abst.

751. Thomas, M.D., Hendricks, R.H., and Hill, G.R.: The action of sulfur dioxide on vegetation. Proc. National Air Poll. Symposium 1949, pp. 142-147, 1951.

The extent of injury to the leaves of plants by sulfur dioxide is determined primarily by the amount of the gas which is absorbed through the stomata. The time-concentration relationships and the absorption-leaf destruction relationships are discussed with respect to environmental factors such as light intensity, atmospheric humidity, and time of day, and also with respect to stomatal apertures, and the carbohydrates in the leaves.

The effect on yield, due to various amounts and types of leaf destruction by sulfur dioxide fumigation, is shown to be the same as that due to equivalent leaf destruction by clipping off the leaves.

Sublethal dosages of sulfur dioxide may have no effect at all, or only a temporary effect on the rate of photosynthesis of alfalfa, depending on the concentration employed. - Authors' Sum.

752. Thomas, M.D., Hendricks, R.H., and Hill, G.R.: Some impurities in the air and their effects on plants. In: McCabe, L.C. (editor): Air Pollution. Proc. United States Technical Conference on Air Pollution. McGraw-Hill Book Co., Inc., New York, N.Y., 1952, pp. 41-47.

In any study of atmospheric contamination which causes injury to vegetation, sulfur dioxide is usually given first consideration because of its well-known effects on plants and because it is often present in greater amounts than other contaminants arising as it does from the combustion of all fuels and sulfide ores. Even when sulfur dioxide is not the major contaminant or is not the cause of the injury to the vegetation, a measurement of its concentration may be a useful index to the over-all contamination. The simple and well-developed methods that are available for the determination of small concentrations of sulfur dioxide in the atmosphere facilitate these studies.

753. Thomas, M.D., and Hendricks, R.H.: Effect of air pollution on plants. In: Magill, P.L., et al. (editors): Air Pollution Handbook, McGraw-Hill Book Company, Inc., New York, 1956, pp. 9-1 to 9-44.

Injury to vegetation caused by air pollution from cities and factories has been well recognized because of many botanical and chemical investigations during the past hundred years. These studies have demonstrated conclusively that the injuries are caused by a small number of contaminants, present in the air in relatively low concentration, of which one of the principal is sulfur dioxide.

About 16 pages of the total of 44 pages, are devoted solely to sulfur dioxide with a short paragraph on page 16 on sulfuric acid mist. This chapter contains some excellent cuts on the effects of sulfur dioxide on plants such as corn, sunflower, tomato, fern, barley and one lot of cuts show markings resembling sulfur dioxide damage. 129 references.

754. Thomas, M.D.: Air pollution with relation to agronomic crops: I. General status of research on the effects of air pollution on plants. Agron. J. 50:545-550 (Sept.) 1958.

Those aspects of air pollution which are of major interest to agriculture are reviewed. Consideration is given particularly to sulfur dioxide, fluorine compounds, and smog. Sulfur dioxide causes 2 types of injury (acute and chronic) on the leaves of plants that are quite typical and have definite diagnostic value. The acute markings are marginal or interveinial collapsed areas, usually of an ivory color, though in some species brown to reddish-brown. The chronic markings are areas of limited cell injury but not of total collapse. They range in color from yellow to brownish-red, to white, and represent either fumigation treatments of insufficient intensity to cause acute markings or prolonged exposures to low concentrations which eventually cause sulfate toxicity. The fluoride pollution problem has 2 principal aspects: first, direct injury to commercial and ornamental plants; and, second, raising the fluoride level in forage above about 30 to 50 ppm., resulting in vegetation that can cause fluorosis in the cattle and sheep that eat it. Particulate fluorides contribute to the latter aspect but probably not appreciably to the former. Forage plants seldom show visible lesions, but must be analyzed for fluoride to show their toxicity. Smog damage to vegetation is of 2 kinds: coal smoke and fog (as encountered in London), of which sulfur dioxide is an important ingredient, and the Los Angeles type smog, which does not contain coal smoke, fog, nor appreciable sulfur dioxide; it is rather a mixture of oxidants (ozone, ozonides, peroxynitrites, peroxyacids, etc.) produced by photochemical reactions between oxides of nitrogen and organic compounds derived from the area's activities: traffic, industry, and incinerators. The identities of the specific compounds which cause crop damage have not yet been established, though occasionally plant lesions are found which can be ascribed to ozone. There is a good correlation between the oxidant level as measured by chemical analysis and the phytotoxicity of smog. The Los Angeles type smog causes characteristic lesions on vegetation, which, however, vary on different types of plants (description of lesions on several garden crops, such as spinach, lettuce, celery, beets, endive, are given). The London type smog has concentrations of sulfur dioxide and suspended solids up to about 0.5 ppm. and about 2.0 mg./m.^{3} respectively. Little effort has been made to analyze the air for other ingredients such as sulfuric acid aerosols, oxides of nitrogen, ethylene, and other organic compounds. The symptoms of ill health in plants of the vicinity (shedding of flowers and leaves of begonias, the blackening death of buds and flowers of certain orchids, and the scorching of the foliage of cinerarias and primulas) are generally different from those usually ascribed to sulfur dioxide injury and may be due in part to toxicants such as those just mentioned. The possibilities of invisible injury (interference with growth or functioning of the plant without production of visible lesions) to vegetation, as a result of toxicants in polluted air, are discussed. - APCA

755. Thomas, M.D.: Effects of air pollution on plants. In: Air Pollution, WHO, Geneva, 1961, pp. 233-278.

There are three principal air pollutants of major interest to agriculture-viz. sulfur dioxide, fluorine compounds, and smog. The last is a complex mixture, only partially understood at this time. There are at least two distinct types of smog, with many intermediate grades: the London type, which is a mixture of coal smoke and fog with enough sulfur dioxide to impart reducing properties to the mixture; and the highly oxidizing Los Angeles type, which usually contains neither coal smoke nor fog, but rather is a mixture of ozone and peroxidized organic compounds formed by photochemical reactions between oxides of nitrogen and innocuous organic compounds such as gasoline vapors or partially burned fuel. In addition to the two types of smog, certain organic compounds, such as ethylene, DDT, and some heterocyclic bases, are known to have powerful phytotoxicity and have done considerable plant damage in some locations.

This chapter gives a review of the literature from 1914 to date. SO_2 damage to various crops and leaves are illustrated in color. Also fluoride injury and damage from smogs as well as the effects of ozone. An extensive bibliography covers a little more than three full pages.

756. Todd, G.W., and Garber, M.J.: Some effects of air pollutants on the growth and productivity of plants. Botan. Gas. 120:75-80 (Dec.) 1958.

Fumigations with ozonated hexene caused a repression in growth of bean plants (varieties Red Kidney and Bountiful) even though they showed no visible symptoms of injury. This effect was evident from measurements of linear growth, leaf area, fresh and dry weights, and fruit production. Both primary and trifoliolate leaves failed to enlarge as much as control leaves when treated with ozonated hexene, although the treatment seemed to have little or no effect on the number of leaves initiated. Primary leaves on treated plants aged and were lost prematurely. Stems of plants treated with ozonated hexene consistently had a higher water content than did stems of control plants. The leaves did not show this relationship. The height growth of pea plants (variety Alaska) was slowed temporarily by as little as a single ½ hr. fumigation with ozonated hexene, although treated plants fully recovered and were growing normally 1 or 2 days later. Ozone alone caused no repression of growth, and repeated fumigations of pea plants with 1-hexene elicited no response. - APCA

757. Van Haut, H.: The analysis of sulfur dioxide effects on plants in laboratory experiments. Staub 21:52-56 (Feb.) 1961.

The evaluation of tolerance limits for sulfur dioxide requires knowledge of the quantitative relationships between the immission and the effect. On the basis of gas exposure experiments in climatic chambers it has been possible to follow the relationship between plant reaction and the individual influencing factors. It has been possible to obtain particular information about the relationship between the harmful effect and the concentration of the sulfur dioxide and the length of time for which it acts, and also about the significance of the stages of development of the reaction of plants to SO_2 influences. Important indications have been obtained from this for the evaluation of tolerance limits in the open air experiments. - English Sum.

758. Weierbach, L.A.: The effects of sulfur dioxide upon plants. Methods of study. Am. J. Botany 13:81-100, 1926.

In studying the effects of sulfur dioxide upon vegetation it was found that methods of determination of the low concentrations of gas causing minimal injury to plants were unsatisfactory. Any method for this purpose may be subject to errors because the gas is invisible, extreme dilutions must be used, changes in temperature cause changes in volume, the gas is adsorbed on surfaces, and oxidation from sulfur dioxide to sulfur trioxide is relatively rapid.

The investigations indicate a point of general interest with reference to effects of the gas upon vegetation near industrial plants which emit sulfur dioxide from smokestacks. The relatively rapid oxidation of sulfur dioxide to sulfur trioxide confines the former to a rather small radius, limiting liability to injury to a more reduced area than is sometimes supposed; consequently the damage done to vegetation is likely to be very slight. - Author's Sum.

759. Whitby, G.S.: The effects of sulfur dioxide on vegetation. Chem. & Indust. 58:991 (Nov. 11) 1939.

A discussion on the effects of sulfur dioxide on vegetation as observed at Trail, British Columbia. The investigation was carried out over a period of eight years, 1929 to 1937, and was considered the most extensive study ever made on the effects of sulfur dioxide on vegetation. The concentration of sulfur dioxide at the United States border was carefully determined throughout the crop season at a point 16 miles from the source of sulfur dioxide. Maximum and average concentrations in part per million are given. The sulfur content of vegetation was determined and was found to diminish as the distance from the smelter increased. It was determined that the sulfur content may rise to four times the normal amount without injurious effect. This is particularly so with prolonged low concentration. The effect on the soil was determined by measuring soluble sulfate, pH and exchangeable bases. The soil near the plant was affected, but this fell off rapidly with increase in distance so that eight miles from the smelter the soil was substantially normal. No effect on water supplies was found.

An appreciable retardation in growth, as determined by annular rings, was noted for trees exposed to the sulfur dioxide. This effect was lost following installation of sulfur dioxide control at Trail. Conifers were found more susceptible during periods of active growth than when dormant. Also, transplanted conifers were more severely affected than native trees. Seedlings were less resistant than older trees.

Environmental effects: any factor favoring active photosynthesis (opening of stomata) favored sulfur dioxide absorption, which increased injury. - BAAP

760. Zahn, R.: Effects of sulfur dioxide on vegetation, results of exposure to gas. Staub 21:56-60 (Feb. 1) 1961.

The tolerance limits for various plants under long-term influence of sulfur dioxide vary between 0.15 and 0.4 ppm. In unlimited immissions irritation threshold curves have been obtained which exhibit scatter over a wide range. Overlapping is possible and this may be considered to be the cause of the series of different resistances.

Subdivision into three resistance groups thus appears to be adequate. A strict distinction must be drawn between continuous and intermittent exposure to gas. For a certain quantity of gas both increasing pauses and also an increase in impulse frequency of the exposure to gas can give rise to an extension of the irritation threshold time. Concentrations below the threshold value on the other hand, may amplify the influence of concentration peaks. - English Sum.

761. Zahn, R.: Investigations of plant reactions to continuous and intermittent sulfur dioxide exposures. Staub 23:343-352 (July) 1963.

The investigations are designed to clarify the relations between the possibilities of combination with regard to time between certain quantities of SO_2 and the plant reaction. At first, the continuous action is dealt with. It is pointed out that the well-known "threshold stimulus functions" of O'Gara and Stratmann are not generally applicable. A new equation that adapts itself much better to the experimental findings is being developed. Knowledge of the course the damage curve is taking is the prerequisite for the analysis for the intermittent gassing. The experiments supply the material for a formula in which the degree of damage is given as a function of concentration and period of action.

The effects of continuous and intermittent immissions are in a certain proportion to each other. The experiments with constant and variable treatments and intervals presented in table and diagram form have shown that the plant damage decreases the longer recovery period and the shorter the period of treatment. The former is limited by the minimum recovery period and the latter by the threshold stimulus time. The sum of the individual findings finds expression in a "recovery function", which serves for the precalculation of the plant reaction from the results of measurement. The working hypothesis is verified by means of examples and used for the explanation of special questions concerning the measuring time interval. - English Sum.

762. Zieger, E.: The sources, diagnosis, and measures taken against industrial smoke damages to forests. Energietechnik 8:487-490 (Nov.) 1958.

Reforestation with fast-growing coniferous species, particularly fir and spruce, has created single-species forests, which are highly vulnerable as compared to natural, mixed forests. The production of waste gases containing high sulfur dioxide concentrations and their dispersal over wide areas inflict acute and chronic injuries to the above species. The phytotoxical threshold value of spruce for SO_2 lies between 1 and 0.5 ppm.; for fir it is still lower. Under certain circumstances, even pine, which is considered to be a smoke-tolerant species, is highly susceptible. Dispersal of waste gases spreads damage over wide areas. Recent increase in the use of powdered coal as boiler fuel has added fly ash as a further threat to plant life. The diagnosis of air pollution damage to vegetation involves 4 basic operations: (1) determination of sulfur concentration in damaged plants, (2) determination of SO_2 content of soil samples, (3) measurement of SO_2 concentration in air samples, and (4) reproduction of prevailing conditions in the laboratory by biological experimentation of fast-growing plants. Other experimental tests in use are the Hartel turbidity test for spruce and spectrophotometric examination of the chlorophyll-A/chlorophyll-B ratio. Preventive measures include reforestation with tolerant strains of coniferous trees, and fencing in of coniferous woods with zones of highly tolerant deciduous species. There is hope for regional planning of forests. Expensive improvements of barrne soils should be planned carefully since such soils may be reserved for future industrial use. - APCA

763. Zimmerman, P.W., and Cocket, W.: Toxicity of air containing sulfur dioxide gas. Contrib. Boyce Thompson Inst. 6:455, 1934.

Experiments were carried out on the effects of sulfur dioxide on plants. The following observations were made.
1. Plants showed certain injuries which were characteristic for the species and for the age of the tissues involved. Leaves were not uniformly attacked. The middle-aged leaves were the most sensitive.
2. All other factors being equal, the amount of injury varied with the concentration of sulfur dioxide and the length of the fumigation period. Buckwheat was the most susceptible species.
3. It was most difficult to obtain uniform plant material. It is indicated that internal conditions at the time the plants are fumigated may control the entrance of sulfur dioxide and thereby affect the resistance of the plants. The degree of turgidity of the leaves was the most important factor. Wilted plants were more resistant than turgid plants because the epidermal pores were closed, and sulfur dioxide supposedly could not enter the tissues. Plants kept in the dark for several hours prior to fumigation were more resistant than those kept in the light. However, the wilted plants offered more resistance than those in a darkened chamber. It seems as though the internal condition of the plants is more important than the external factor. - BA\P

764. Anderson, D.R., and Manlik, F.P.: Sulfuric acid corrosion in oil-fired boilers. Studies on sulfur trioxide formation. ASME Trans. 80:1231-1238 (Aug.) 1958.

Experimental studies on economizer and air-heater corrosion resulting from the formation of sulfuric acid in residual-oil-fired boilers are described. Factors controlling the oxidation of sulfur dioxide to sulfur trioxide have been investigated in a small experimental boiler. The sulfur trioxide content of the flue gases was determined indirectly by measuring the corrosion of and sulfate deposition on a steel specimen maintained at a controlled temperature. In an initially clean boiler, approx. equal quantities of sulfur trioxide formed in the flame, furnace, and convection sections, while less formed in the economizer-air heater section. Nickel, iron, sodium, and vanadium in the fuel, each decreased the corrosion normally experienced by the test specimen, the magnitude of the effect increasing in the order given. Combinations of sodium and vanadium in the fuel were found to decrease corrosion in an initially clean furnace, but boiler deposits from certain combinations of these elements were found to increase corrosion substantially. This catalytic effect is predominant over extended periods of time. Discussion. - APCA

765. Bowen, F.J., and Gropp, A.H.: A polarographic study of the corrosion of iron and some ferrous alloys by sulfur dioxide. Corrosion 14:50-54 (Dec.) 1958.

Sulfur dioxide is one of the most serious offenders of the gases which may contaminate an atmosphere, because of its corrosive effect upon many metals when moisture is present. A study was made of the manner in which SO_2 attacks iron and ferrous alloys. A polarographic method was used to follow the changes in the SO_2 concentration. Tests were made on 1 pure iron and 7 low alloy steels exposed to SO_2 over 12-hour periods. Extensive data are reported on the rate of consumption of SO_2 by the various test samples. A corrosion mechanism involving the reduction of sulfurous acid by iron to give the sulfide is discussed. - APCA

766. Burt, E.W.: A study of the relation of visibility to air pollution. Am. Indust. Hyg. A. J. 22:102-108 (April) 1961.

Attempts to determine a workable relationship between visibility and the soiling index of air sampling tapes are described. It is shown that visibility is a function of relative humidity, whereas soiling index is not. The visibility soiling index humidity correlations were significantly different from zero at a high level of confidence, but they are not of such high quality as to permit good quantitative estimates of soiling index from measurements of visibility and humidity. The reproducibility of soiling index within reasonable limits is questioned, since under nearly identical visibility and humidity conditions the soiling index values vary over a relatively wide range. - APCA

767. Corrosion and its prevention. Steel Processing 41:650-655, 671 (Oct.) 1955.

Wherever iron and steel are used, the problem of corrosion arises. The problems may be different according to whether the corrosion takes place in air, in water, or in the soil, but in all of them the effect may be alleviated by 1 of 4 methods: (1) alterations in the corrosive medium; (2) modifications in the design of plant or apparatus exposed to corrosion; (3) changes in the composition of the iron or steel; (4) efficient protective measures. Researchers of the Corrosion Committee of the British Iron and Steel Research Association have shown that corrosion will not occur in an atmosphere of relative humidity of less than 70%, and that where the relative humidity is high enough to permit corrosion to occur, the degree of atmospheric pollution is the governing factor. The practice of drying gas in the gas industry is one manifestation of this principle and as their pamphlet states, in the few instances where the engineer can control either the humidity or the pollution present, virtually complete protection can be achieved. - APCA

768. Cunningham, O.C., and Addington, L.H.: The value for milk production of alfalfa hay injured by sulfur dioxide gas. Proc. 20th Annual Meeting Western Div. Am. Dairy Sc. A., 1934, pp. 39-41.

In the vicinity of industrial plants, especially smelters, vegetation is sometimes subjected to concentrations of SO_2 gas sufficiently great to cause injury. Alfalfa is one of the plants that is the most likely to be affected by the SO_2 gas. This injury consists of a collapse of the leaf tissues; the affected portions presenting a bleached appearance. The injury first occurs at the margin of the leaflet and progresses towards the center of the leaflet between the ribs and the mid rib. The question has been raised by farmers and others in areas where the alfalfa crop is sometimes affected by SO_2 gas as to whether the injury to the leaflets affects the feeding value for milk production of the resulting hay. - Authors' Abst.

769. Galegar, W.C., and McCaldin, R.O.: Air pollution as determined by corrosion rates in test materials. Am. Indust. Hyg. A. J. 22:187-191 (June) 1961.

Some of the corrosive effects of atmospheric pollutants may be evaluated by means of a relatively simple test based on the weight gain that occurs when an iron disc is exposed to the atmosphere for a few weeks. The weight gain is due to the formation of corrosion products on the surface of the test material. Field tests are easily performed, and a minimum of laboratory equipment is required for analysis of samples. Consequently, this furnishes an inexpensive method to determine relative corrosion rates in different areas of a community, as well as trends in corrosion rates over a period of years. The method does not allow for identification of pollutant species. Consequently, it should be considered as a screening technique to be used in connection with evaluation of specific emissions and atmospheric concentrations of corrosive agents.

A field test of this method was conducted in Tulsa, Oklahoma, and a substantial variation was found in atmospheric corrosiveness in different places within the city. Corrosion as measured by this method was greatest in the western portion of Tulsa along the Arkansas River. - Authors' Sum.

770. Greenblatt, J.H., and Pearlman, R.: The influence of atmospheric contaminants on the corrosion of steel. Chem. Canada 14:21-23 (Nov.) 1962.

The effects of some possible atmospheric contaminants on the corrosion of steel at 3 different humidities and temperatures were investigated. The rates measured at 8 sites after 1 and 2 yrs. indicated that SO_2 pollution was the determining factor. After 5 yrs. exposure, the rate at a marine rural site was greater than at 2 industrial inland sites. Because of the shifting interplay of corrosion determining factors, in outdoor exposure data, a laboratory investigation was made to determine if the various factors showed similar trends in short-term laboratory studies. The results of the laboratory tests and the correlation with site data are described. - APCA

771. Greenburg, L., and Jacobs, M.B.: Corrosion aspects of air pollution. Am. Paint J. 39, 64, 68, 70, 74, 76, 78 (July 11) 1955.

Atmospheric corrosive agents comprise oxidizing agents (O_2, O_3, oxides of nitrogen, HNO_3, and peroxides), acids (SO_2, SO_3, H_2S, HCl, CO_2, and tar acids), salts (NH1, sulfate and NaCl) and occasionally alkalis. Their effect on metals, building materials, e.g. stone, textiles, nylon hosiery, leather, rubber, and protective coatings are discussed. Corrosion may also result from the direct or indirect action of airborne bacteria. - APCA

772. Holbrow, G.L.: Atmospheric pollution: Its measurement and some effects on paint. J. Oil Col. Chem. A. 45:701 (Oct.) 1962.

This paper describes the various standard methods for the measurement of atmospheric pollution. Data collected from two paint exposure sites (suburban and industrial) indicate the nature and concentration of pollution that is likely to affect paint films. Specific effects of pollution on paint films are the attack on young films by sulfur dioxide causing a delay in drying; production of water sensitivity and possible attack on certain pigments; formation of crystalline bloom; and staining.

773. Johnstone, H.F.: Properties and behavior of air contaminants. Indust. Med. & Surg. 19:107-115, 1950.

S gases and vapors, N and halogen compounds, CO, CO_2, exhaust gases, peroxides and O_3 are discussed as to their physiological effects, sources, prevalence and means of removal. Aerosol contaminants are discussed as to their physical properties, viz., effect on visibility, deposition, coagulation, evaporation, Brownian diffusion, electrical properties, dispersion and physiological effects, and sources. The gases and vapors present in contaminated air are of interest mainly from their chemical behavior, e.g., conversion to obnoxious compounds by reaction with other contaminants, or with O_2 in sunlight, whereas the physical properties of aerosols of suspended particulates, e.g., effective particle size, are of most importance. - KB

774. Kemp, W.E.: Product fallout - A serious corrosion problem. Indust. Eng. Chem. 51:75-76 A (July) 1959.

Fallout areas occur in coke and steel plants, particularly those adjacent to, or downwind from, coke quenching towers where all exterior steel surfaces are subject to continuous fallout of moisture, ammonium chloride, sulfurous acid, and corrosive dusts as well as traces of oil. Similar conditions exist in many chemical plants where chlorination or sulfonation processes are employed and acidic and alkaline by-products are carried into the atmosphere. The corrosion rate of carbon steel in these areas reaches fantastic proportions and may exceed 0.5 in./yr. Experience has shown that the failure of paint films and protective coatings in fallout areas, assuming an original pinhole or holiday-free surface, usually starts from microscopic cracks in the protective coating. Failure is usually not from actual destruction of the coating by corrosive agents, although this is a contributing factor. Performance of a protective coating in a fallout area depends on: Surface preparation, film thickness, adhesion of organic film, elasticity or ductility of the organic film, and film resistance to the environment. Most important, recognize that a problem of exterior corrosion and corrosion fallout exists -- through a good corrosion survey before the plant or equipment is built and plan the protective coating system accordingly. - APCA

775. Parker, A.: The Destructive Effects of Air Pollution on Materials. Sixth Des Voeux Memorial Lecture. National Smoke Abatement Society, London, S.W. 1, 1955.

The most important pollutants discharged from the use of fuels, in relation to their destructive effects on materials, are smoke, grit and dust, and acid oxides of sulfur. Motor vehicles, particularly those driven by diesel engines, frequently emit clouds of black smoke of an oily nature. Air pollution by the invisible gases, carbon monoxide, oxides of nitrogen, aldehydes and certain hydrocarbons resulting from the imcomplete combustion of fuels in boilers and other furnaces, domestic heating appliances, and internal combustion engines. The dispersion of the pollutants from their points of discharge is affected by many factors, including the height of the chimney or other point of discharge, the velocity and amount of the discharge, velocity and direction of the wind, and other meteorological and topographical conditions. In relation to damage to buildings and materials of various kinds, sulfur dioxide is the most important of the gaseous pollutants because of the large quantities emitted into the atmosphere and the presence of moisture and air it changes to the highly corrosive sulfurous and sulfuric acids. Estimates of the cost to the country of the damage caused in various ways by air pollution are those given in the report of the Beaver Committee published in Nov. 1954. Direct costs are £ 150 million a year. - APCA

776. Regan, C.J.: A Chadwick lecture on air pollution. Smokeless Air J. Nat. Soc. Clean Air 88:67-76, 1953.

Report of lecture at Royal Society of Arts, Oct. 15, 1953. Describes the solid matter and injurious gases (chiefly SO_2) emitted into the air in Britain, and their effects (corrosion, damage to health and agriculture, dirt, nuisance and waste of fuel). SO_2 especially on presence of solid particles, attacks, metal, stone and fabrics. London Fog in Dec. 1952 caused 4000 deaths. Effect of sulfur oxides on lung cancer and of petrol and diesel fumes on lung is discussed. Remedial measures are considered. - PHEA

777. Ross, T.K., MacNab, A.J., and Layland, B.E.: An aspect of the corrosion of mild steel by combustion gases. J. Inst. Fuel 33:540-542 (Nov.) 1960.

The short-term corrosion of mild steel by sulfur dioxide in reducing atmospheres above dewpoint, is examined. The different nature of the attack compared with that experienced in the presence of oxygen is shown. The quantitative effects of temperature and concentration are such that in both cases the scaling rate varies with the square root of the sulfur dioxide concentration. In mixtures of sulfur dioxide and nitrogen scaling proceeds approx. as the 3rd power of the temperature, but the presence of hydrogen increases this relationship to about the 5th power. - APCA

778. Sanyal, B., and Bhadwar, D.V.: The corrosion of metals in synthetic atmospheres containing sulfur dioxide. J. Sc. Indust. Res. (New Delhi) 18A:69-74 (Feb.) 1959.

The mechanism of atmospheric corrosion of metals has been investigated by measuring the rates of corrosion of aluminum, copper, nickel, zinc, and mild steel in humid synthetic atmospheres containing sulfur dioxide. The effects of varying humidity, temperature, sulfur dioxide concentration, duration of exposure of the metals, singly or in combinations, on the rates of corrosion have also been investigated. Each metal requires a min. humidity for the initiation of corrosion. Aluminum exhibits a critical humidity, 80% relative humidity, at which the rate of corrosion is accelerated; mild steel exhibits critical humidities at 60 and 75%, copper and zinc do not exhibit any. The rates of corrosion of the metals depend on the temperature of the atmosphere, the thickness of the moisture film on the metal surface, the nature of the corrosion products and the permeability of the films of these products to moisture and acid. Rise in temperature increases the rate of corrosion as a result of acceleration of the chemical reaction between the metal and the acid, up to a point, beyond which it falls due to lower solubility of sulfur dioxide in water vapor which does not condense on the metal surface. - APCA

779. Smalley, G.E., and Klohr, J.W.: Recovery of refinery sulfur in air pollution control. In: Mallette, F.S. (editor): Problems and Control of Air Pollution. Reinhold Publishing Corporation, New York, 1955, pp. 191-201.

In the past, sour or sulfur containing crudes were not generally processed because they added corrosion problems and increased the processing facilities required to meet petroleum product specifications. With the decline of sweet crude reserves it soon became apparent that in order to supply the demands for petroleum products more sour crudes must be processed. By the end of 1955, approximately 1000 tons per day of sulfur will be recovered from sour gases at petroleum refineries throughout the United States. Since these refineries are located near population centers, the installation of sulfur recovery plants provides an important aid to air pollution control. The recovered sulfur will represent a reduction of 2000 tons per day of sulfur dioxide which otherwise would be released to the atmosphere.

780. Thomas, M.D.: Sulfur dioxide, sulfuric acid aerosol and visibility in Los Angeles. Internat. J. Air & Water Poll. 6:443-454 (Nov.-Dec.) 1962.

An automatic analyzer for simultaneous recording of sulfur dioxide and sulfuric acid aerosol in air, has been used to monitor the atmosphere in Los Angeles. Downtown, when the base of the inversion ceiling and wind speeds were low and oxidants were high (Rule 57 days) the oxidation of sulfur dioxide to sulfuric acid was maximal. Acid levels reached 5-20 per cent of the total sulfur with sulfur dioxide levels of 5-20 p.p.h.m. In industrial El Segundo, the rate of oxidation of sulfur dioxide was about 60 per cent of the rate downtown under similar weather conditions. Presumably the accompanying smog concentrations were also lower in El Segundo. Visibility in areas immediately downwind from large consumers of fuel oil was reduced slightly on Rule 57 days, by burning oil containing 1.5 per cent sulfur instead of natural gas, but no effect was found at greater distances. Eye irritation downtown was independent of the amount of fuel oil burned. - Author's Abst.

781. Whittingham, G.: The corrosive nature of combustion gases from carbon monoxide flames containing sulfur oxides. J. Appl. Chem. 5:316-322, 1955.

Mild steel corrosion probes have been used to determine the relation between surface temperature and amount of iron corroded by the flue gases of relatively low moisture content from a diffusion flame of carbon monoxide, to which additions of sulfur dioxide were made. Complementary measurements have been made of the percentage conversion of sulfur dioxide to sulfur trioxide and of the rates of acid buildup on a dewpoint meter. Over the temperature range employed, corrosion showed a maximum at 66° to 70°, and humidity of combustion air was found to have a significant effect on corrosion.

From the dewpoint meter readings and other data, theoretical rates of acid deposition on the corrosion probe have been calculated and these and the experimental values are compared and discussed. - Author's Abst.

782. Air Sulfur Dioxide No. 1. A Study Conducted by the Analytical Reference Service Training Program for the Division of Air Pollution. USDHEW, PHS, Cincinnati, Ohio, June 1963.

Since sulfur dioxide is frequently used as an index of air pollution, a study to permit evaluation of precision and accuracy obtainable by analytical methods was considered desirable. A poll of Analytical Reference Service members revealed interest in a study designed to evaluate the colorimetric method of West and Gaeke (Anal. Chem. 28:1816, 1956). An additional intent was the evaluation of the stability of the sulfur dioxide samples over a two-week period.

The SO_2 sample was prepared without the addition of nitrogen dioxide, the one significant interference for the West-Gaeke method. West and Ordoveza (Anal. Chem. 34:1324 (Sept.) 1962) report a modified procedure for the elimination of this interference by the addition of sulfamic acid to decompose nitrite.

Perry and Tabor found that about 15% of the sulfur dioxide content is lost from samples after two weeks of storage. To overcome this loss, the study attempted to stabilize the sample by adding 0.5 gm. of gum arabic per 100 ml of 0.1 M sodium tetrachloromercurate as a preservative. Addition of this preservative was apparently effective as the analyses of the three concentrations by the ARS staff failed to show any loss of SO_2 after 16 days storage. The standard deviation increased through the three samples as the concentration increased. Precision as indicated by the coefficient of variation improved with each increase of concentration. Data tabulated in Table 4 indicate that this method is accurate and precise even when used by laboratories not routinely determining SO_2 or performing the determination for the first time. - From Text and Sum.

783. Aldred, L., and Clough, J.: Continuous multipoint hydrogen sulfide detector. Indust. Chem. 29:515-520 (Nov.) 1953.

The purpose of this instrument is to detect hydrogen sulfide in air which is continuously drawn from six sampling points. The air is passed through a sodium nitroprusside solution. Hydrogen sulfide causes a reversible color change which is measured photo-electrically. A recorder included in the output circuit registers changes in concentration. When the concentration sampled reaches 50 ppm, visible and audible warnings are given.

784. Alekseeva, M.V., and Bushtueva, K.A.: Separate determination of sulfur dioxide and aerosol sulfuric acid in air. Gig. i Sanit. No. 4, 13-16, 1954.

Sulfur dioxide is determined colorimetrically after absorption in 0.01 normal sodium hydroxide in 5% aqueous glycerol, followed by treatment of a 2 ml. specimen with fuchsin-formaldehyde reagent. A fresh 3 ml. of the absorbent solution is then blown free of sulfur dioxide by air after acidification with 0.3 normal hydrochloric acid, and the usual sulfate determination is made.

785. Altshuller, A.P., Sleva, S.F., and Wartburg, A.F.: Spectrophotometric determination of olefins in concentrated sulfuric acid. Anal. Chem. 32:946-954 (July) 1960.

The determination of the type and quantity of the olefinic constituents emitted by various combustion devices into the atmosphere is necessary for an understanding of the type of air pollution termed "smog". The reactivity of olefins in simple mixtures with ozone, atomic oxygen, or nitrogen dioxide as well as in diluted and irradiated automobile exhaust gases has been shown to be appreciably greater than the reactivity of paraffinic, acetulenic, or aromatic hydrocarbons.

A new spectrophotometric method for the determination of small quantities of olefins is based on the absorbance produced in the 300- to 310-mμ range from their reaction with concentrated sulfuric acid. The procedure is insensitive to ethylene under all conditions studied and to propylene concentrations below 1,500 ppm. Propyl and higher molecular weight alcohols react to form absorbing products at 300 mμ. Some higher molecular weight aldehydes, nitrogen dioxide and sulfur dioxide interfere moderately. The method has been applied to the analysis of a number of two-component liquid mixtures and to gas mixtures containing butenes, 1-hexene or 1-hexene-benzene in air. The experimental evidence favors carbonium ions as the absorbing species. - Authors' Abst.

786. Ambrose, P.M., Larson, L.P., and Stanley, B.I.: Sulfur and pyrites. In: Minerals Yearbook, 1961, USDIBM, vol. 1, pp. 1175-1198.

This paper reports on a survey of the production and consumption of sulfur in all forms in many parts of the free world. The United States production of sulfur, in all forms, increased at a greater rate than world output, mainly because new sulfur terminals were stocked with molten sulfur. The most notable event that occurred during the year was the conversion, by a large segment of the sulfur-consuming industry, to the use of molten sulfur.

In the section "Technology" authors describe new micromethods for determining sulfur in organic compounds by gas chromatography; a fluorsolvent process for acid gas removal; a new process to produce sulfur dioxide from sulfur and sulfur trioxide for liquefaction; and a report on an investigation on preparation of sulfide minerals by viological methods.

Authors also report that an aerosol layer consisting mainly of sulfur particles was discovered in the atmosphere by workers at the Cambridge Research Laboratories of the U.S. Air Force (Chemical and Engineering News vol. 39, no. 17, April 24, 1961, p. 59). "This layer completely envelops the earth with a shell 3 miles thick about 11 miles above the earth. The existence of this layer was first indicated by air samples collected during studies of fallout distribution. Detailed studies showed that the concentration of particles between 0.1 and 2 microns in size within the layer was about 16 per cubic inch-three times the number at adjacent levels. Electron microprobe analyses of samples showed that the layer was about 85 percent sulfur; silicon, iron, and aluminum also appear in some samples. This analysis, together with particle absorbency determinations and electron diffraction studies, indicated that the particles were ammonium sulfate. Iron and silicon content of some samples may have been due to temporary fluctuations in micrometeorite influx. The aerosol layer was thought to originate at its observed position from hydrogen sulfide or sulfur dioxide that were chemically changed by sunlight or ozone. The layer may explain purple light, the red disk seen above the point of sunrise or sunset."

787. Anon: Removal of sulfur oxides from flue gases. Chem. Training J. 152:14 (Jan. 4) 1963.

This paper gives a short description of the Reinluft process at Warren Spring. In addition to the pilot plant at Warren Spring which treats 16,000 cu. ft./hr. of flue gas, three large experimental plants are planned in Germany. Two of these are definitely under construction and the third is still in the planning stage. The plants in Germany are being subsidized by the government, to the extent of two-thirds of the cost of construction.

788. Anon: Sulfur removal from power station gases. Chem. Trade J. Vol. 152 (June), 1963, p.903

This paper deals with work in progress to devise a dry absorption process which will be capable of removing sulfur oxides from hot flue gases. Experiments with solid absorbents ranging from active carbons to semiconductive mixtures of oxides are being made. The "falling cloud" technique in which a fine dispersion of absorbent is allowed to cascade freely through the rising gas stream, is found to be a suitable process of using the absorbents. High absorbent efficiencies for some absorbents have been found and a pilot-plant examination is being carried out.

789. Anon: New way of measuring sulfur fumes. New Scient. Vol. 19 (July) 1963.

Dr. J. Novak of the Polarographic Institute of the Academy of Sciences in Czechoslovakia uses polarographic and coulometric methods of analysis. The recorder responds to changes in concentration within 30 seconds. Sensitivity of 0.3 ppm for full scale deflection of the recorder can be obtained.

790. Anonymous: Sulfur peroxide solves ash precipitation problem. European Am. News, March 3, 1964.

An injection process developed by Lodge and Cottrell is being described. Due to its high electrical resistivity ash from certain coals does not settle on the electrodes of the electrostatic precipitators which are used to separate the ash from flue gases. When sulfur peroxide is injected into the ash laden gas at the rate of about 10 ppm, separation efficiency is increased to as high as 95-99%. Thus the SO_3 is completely absorbed by the ash and it is stated that there is no risk of sulfuric acid formation.

791. Apel', IA.A.: Methods of determining sulfates, chlorides, and bituminous matters in atmospheric dust. Gig. i Sanit. 26:78-79 (Dec.) 1961.

Some changes were introduced into the techniques of a chemical analysis of dust by the sedimentation method. The liquefiable sulfates were determined by nephelometric instead of gravimetric method; the chlorides by mercurimetric instead of argentometric method; and the bituminous matter by microextraction using the Zaitsev and Polezhaev condensers instead of the Soxhlet apparatus. This microextraction apparatus is described. The features of the proposed methods are indicated. - APCA

792. Bell, F.A., Jr.: Sulfur Dioxide in Air by the West Method. USDHEW, PHS, Div. of Air Pollution, Jan. 31, 1961.

This method is not only useful for individual SO_2 determinations but also useful for multiple-sample automatic collections. The sample is collected in sodium tetrachloromercurate solution which remains stable until the addition of p-rosaniline and formaldehyde, after which color develops. For instance, a number of samples could be collected over a period of time, the indicators added at the same time and analyses run one after the other. Since the blank stays almost colorless, the blank for the oldest sample could be used for all samples with negligible effect upon results. - Author's Abst.

793. Bender, D.F., and Jacobs, M.B.: Stabilization of sulfide in aqueous solution. Analyst 87:759-600 (Sept.) 1962.

A method for the preparation of stable colloidal solutions of sulfide is presented. Aqueous sodium sulfide (standardized by iodeometric titration followed by rapid quantitative dilution to the desired concentration) was added to a known solution of lead acetate containing gum arabic. The uniformly dispersed lead sulfide suspension was tested with the methulene blue - cadmium hydroxide procedure. Low concentrations (1.0 µg/ml) of aqueous sulfide, which previously were stable for less than 5 minutes, can now be made stable for at least 2 days. This method is valuable in the preparation of calibration curves for the spectrophotometric determination of hydrogen sulfide. It may be useful for stabilizing samples of hydrogen sulfide collected from the air. - Authors' Abst.

794. Bertolacini, R.J., and Barney, J.E., II: Colorimetric determination of sulfate with barium chloranilate. Anal. Chem. 29:281-283, 1957.

A new method for the colorimetric determination of sulfate is based on the reaction of solid barium chloranilate with sulfate ion at pH 4 in 50% ethyl alcohol solution to liberate highly colored acid-chloranilate ion. The broad absorption peak of the ion at 530 mµ is used for the determination. Ethyl alcohol decreases the solubilities of barium sulfate and barium chloranilate and increases the sensitivity of the method to about 2 p.p.m. of sulfate. Precision and accuracy are about 1%. Interfering cations are removed with ion exchange resins. Phosphate, oxalate, bicarbonate, chloride, and nitrate do not interfere. The method has successfully been applied to the determination of sulfate in water and of sulfur in petroleum products. - Authors' Abst.

795. Bowden, S.R.: Improved lead dioxide method of assessing sulfurous pollution of the atmosphere. Internat. J. Air & Water Poll. 8:101-106 (Feb.) 1964.

The lead dioxide method for the investigation of atmospheric pollution, sometimes known as the lead peroxide candle method, measures the reaction of the sulfurous constituents of the air with a prepared surface of lead dioxide. The rate of reaction expressed in mg. SO_3/100 cm.^{2} surface/day, is influenced by the prevailing temperature, humidity, and wind velocity, and the returns include any solid sulfates which may be deposited from the air, but results depend essentially on the concentration of the SO_2 in the air. The modifications of cylinder and processing have no significant influence upon the results. A cylindrical louvered box could advantageously replace the present cubical box, but results would be raised approx. 20% to a level of that given by the cowl used before 1945, therefore it would be necessary to apply a correction. - APCA

796. Bretsznajder, St.: Utilization of sulfur dioxide in industrial flue gases. Presemyst Chem. 31, No. 8:276-284, 1952.

Various methods of absorbing the SO_2 contained in industrial waste gases are reviewed, and the advantages and disadvantages of each method are discussed. 28 references. - PHEA

797. Burgess, W.D.: Sulfur dioxide recovery process as applied to acid plant tail gas. Chem. (Canada) 8:116-118, 120 (June) 1956.

The production of sulfuric acid at Trail, B.C., was originally undertaken to eliminate atmospheric pollution caused by metallurgical waste gases containing sulfur dioxide which resulted in damage to vegetation both locally and beyond the U.S. border. The process is described. The gas flow rate corresponds to normal practice.

798. Bushtueva, K.A., Polezhaev, E.F., and Semenko, A.D.: Electroencephalographic determination of threshold reflex effect of atmospheric pollutants. Gig. i Sanit. 25:57-61, 1960, in: Levine, B.S. (translator and editor): U.S.S.R. Literature on Air Pollution and Related Diseases. A Survey. U.S. Dept. of Commerce, Office of Technical Services, Washington, D.C., Vol. 7, 1962, pp. 137-142.

This paper is a report of attempts to test suitability of the electroencephalographic method for the determination of unusual simple allowable concentration limits of air pollutants. As a first step tests were made of the effect of odor-emanating substances and other stimulating or irritating substances on reflex responses.
Substances investigated were SO_2 and H_2SO_4 aerosol. Investigations here reported point to a high sensitivity of the method of "electrocortical" conditioned reflexes as a procedure for the study of threshold effect of irritating and odor-emanating substances on the reflexogenic zone of respiratory organs.

799. Cadle, R.D., Rolston, M., and Magill, P.L.: Cold-surface collection of volatile, atmospheric contaminants. Anal. Chem. 23:475-477, 1951.

The analysis of contaminated atmospheres is often complicated by the low concentrations involved. However, condensation on cold surfaces can often be used to concentrate volatile materials. The sampling of volatile atmospheric contaminants by cold-trap techniques was studied in order to determine the efficiency of such methods and to develop improved equipment. Formaldehyde at concentrations in air of a fraction of a part per million was collected with about 80% efficiency at liquid nitrogen temperatures using metal packing in the traps. Without packing, only 50% efficiency was achieved. Similar results were obtained with low concentrations of benzene and sulfur dioxide. A convenient cold-trap system was developed consisting of a dry ice-cooled coil followed by a liquid nitrogen-cooled, metal-packed U-tube. The results of this work have been very helpful in studying the composition of smog in Los Angeles County and should be applicable to many air pollution problems. - Authors' Sum.

800. Carpenter, S.B., and Sparkman, R.E.: Adaptation of Titrilog for field mobile sampling. J. APCA 5:195-196 (Feb.) 1956.

The article describes methods for installation and operation of the Titrilog in an automobile and a helicopter for mobile field sampling for sulfur dioxide. Frequent calibration is required and a method of calibration of the Titrilog using sulfur dioxide is also described. - Authors' Sum.

801. Cheaper gas by new process. The gas recycle hydrogenator process. Smokeless Air, Spring 1963, pp. 222-223.

A revolutionary new gas production process has been developed by the Gas Council Midlands Research Station at Solihull. A new application of hydrogasification was developed by a team of scientists working under Dr. F. J. Dent. Several oil gasification plants have been brought into operation since the first commercial-scale unit of the Segas process was commissioned in 1953. All the distillate will be pre-treated to remove sulfur, so that the final town gas will be sulfur-free and virtually non-toxic. Pilot plant tests were very promising. The first commercial plant has now been ordered in England. - Author's Abst.

802. The Chlorine Oxidation of Sulfur Compounds in Dilute Aqueous Solution. Atmospheric Pollution Technical Bulletin, no. 18. June, 1963.

In recent years, the pulp industry has sought methods for decreasing the concentration of sulfur-containing chemicals in stack gases. The sulfur content of the gases requiring treatment is below the level where economic recovery is feasible. One method of treating such gases would be to scrub the gases with water, removing the water soluble sulfur compounds. These sulfur compounds could then be oxidized with chlorine or another oxidant and released.

In order to determine the chlorine requirements of this system, investigations were made of the chlorine oxidation of hydrogen and sodium sulfide, methyl mercaptan, dimethyl sulfide, and dimethyl disulfide. - Author's Abst.

803. Compte, M., and Colin, A.: Purification of flue gases from sulfur plants at Lacq. Pap. to Congr. Ass. tech. Indust. Gaz.France (June) 1962; abridged in Gas World 156:286 (Sept. 15) 1962.

This paper discusses the results obtained by scrubbing of flue gases with ammonium salt solutions in an apparatus with a very low pressure loss. Because of the obtained results air industrial installation was designed, the features of which were based on the results obtained with a pilot installation. It was found that the extrapolation was entirely valid.

804. Cotham, R.L.: Electrostatic precipitation of sulfuric acid mists. Proc. Clean Air Conf. Univ. N.S. Wales 2:1-12, 1962.

The process of electrostatic precipitation offers a reliable method at moderate cost, to remove particulate matter from effluent gas streams, and reduce atmospheric pollution. High collection efficiencies are maintained over a wide particle size range including submicron sizes. For the treatment of gaseous effluent from contact H_2SO_4 plant efficiency tests have indicated average migration velocities of 0.40-0.60 ft./sec. with efficiencies of 99.7%. The Deutsch equation is a means for equipment comparisons and design. Drift or migration velocity is a function of tube size for a given electrode potential difference. The most important feature of electrostatic precipitators is the ability to remove very small concentrations of finely divided particulate matter, at high efficiency from large gas flows. - APCA

805. Craxford, S.R., Poll, A., and Walker, W.J.S : Recovery of sulfur from flue gas by use of ammonia. J. Inst. Fuel 25:13-14 (Jan.) 1952.

Before the World War II Messrs. Simon-Carves and the Metropolitan Borough of Fulham proposed the use of ammonia for scrubbing the flue gas emitted from electricity generating stations, in order to reduce the pollution of the atmosphere by oxides of sulfur and at the same time to recover the sulfur in a useful form. They found it difficult to control the composition of the scrubber liquor so that neither ammonia nor sulfur dioxide was lost with the scrubbed gas, but they invented an electrical-conductivity vapor-pressure recorder which they hoped would overcome this difficulty. Arrangements were made for the application of this instrument to the control of a scrubber to be tested at the Fuel Research Station, and this paper describes the small plant built to treat 1,000 cu.ft./hr. of flue gas from a Lancashire boiler. As a scrubber this plant was entirely satisfactory, and when the composition of the liquor was right the concentration of sulfur dioxide in the exit gas was found regularly by analysis to be as low as 0.0005 per cent, which corresponded to the removal of some 99 per cent of the sulfur dioxide in the flue gas. The control of the composition of the liquor was at first difficult, owing to the building-up of too high concentrations of sulfites and bisulfites, but the addition of a little oxidation catalyst ($MnSO_4$) overcame this difficulty. Subsequently, when the metalwork had become corroded, the iron oxide in the system was found to be a sufficiently good oxidation catalyst. - Authors' Abst.

806. Cummings, W.G., and Redfearn, M.W.: Mixtures of sulfur dioxide and air for calibrating sulfur dioxide recorders. Chem. & Indust. (London) No. 25:809 (June) 1957.

As part of the atmospheric pollution research program of the Central Electricity Authority, an automatic SO_2 recorder and apportable SO_2 meter have been developed which operate in the range 0-50 parts SO_2 in 10^8 parts of air. The diluting air is freed from acid gases by passing it through sodalime. Calibrated flow-meters and rota-meters indicate the flow rates of SO_2, air and SO_2/air mixtures at each stage of the mixing. - APCA

807. Cummings, W.G., and Redfearn, M.W.: Instruments for measuring small quantities of sulfur dioxide in the atmosphere. J. Inst. Fuel (London) 30:628-635 (Nov.) 1957.

An automatic recorder and a portable meter have been developed for measuring small quantities of sulfur dioxide in air. Designed especially for atmospheric pollution work, both instruments are sensitive to 1 p. sulfur dioxide in 100 m.p. of air over the range 0-50 pphm; the range can be extended by simple adjustment. The recorder is intended for long periods of continuous operation on a fixed site; the portable meter can be used in a small car for rapid surveys in a particular area. The cost of the instruments has been kept to a minimum and long field trials have proved their reliability. Investigations with these instruments are showing that when the plumes from modern power stations reach the ground the concentration of sulfur dioxide in them is low. - APCA

808. Demidov, A.V., and Mokhov, L.A.: Accelerated Methods for the Determination of Injurious Gaseous and Volatile Substances in the Air. Medgiz, Moscow, 1962, 146 pp.

This book deals with rapid methods for the determination of injurious gaseous and volatile substances in the air. For most of the 1st listing, where the gases are mainly inorganic in nature, the methods given are both qualitative and quantitative. Toxicological levels are also given for ammonia and aliphatic amines, arsenous acid, and antimonious acid. The substances on the 1st listing are: carbon monoxide, oxides of nitrogen, hydrogen peroxide, ozone, chlorine, hydrochloric acid, hydrogen sulfide, carbon disulfide, ammonia and aliphatic amines, arsenous acid, antimonious acid, fluorine, sulfur dioxide, mercury vapor, hydrocyanic acid, and the nickel tetracarbonyl radical. Methods are also given for the following, mostly organic, volatile substances: vapors of formaldehyde, ethyl alcohol, liquid fuel, products of heat-oxidized mineral lubricants, phosgene, benzene, ethylene, aniline, and acetone. - APCA

809. Dickinson, J.E.: The operation and use of the Titrilog and the Autometer. J. APCA 6:224-227 (Feb.) 1957.

The Titrilog and the Autometer are the most commonly used instruments now available for the determination of sulfur dioxide. Either principle is adaptable to the measurement of sulfur dioxide, but careful selection is necessary to insure using the best instrument for each sampling situation. Each has advantages and limitations which must be understood. For a permanent or semi-permanent installation where sulfur dioxide measurement is the principal or only purpose, the Autometer or the Titrilog, will be satisfactory. The Autometer, however, will probably be simpler and less expensive to operate for this kind of sampling and will be subject to fewer interferences than the Titrilog, if properly installed and maintained. In situations which require determinations of other sulfur compounds, or where portability is an essential or even desirable feature, the Titrilog should be selected. There are, of course, other instruments or sampling methods which could be used successfully for some of these purposes, but they have not been considered in this discussion.

810. Duckworth, S., Levaggi, D., and Lim, J.: Field dynamic calibration of SO_2 recording instruments. J. APCA 13:429-434 (Sept.) 1963.

The described apparatus and procedure are adequate for the realistic field dynamic calibration of an entire SO_2 monitor system in situ. Such a calibration simulates natural conditions. It ensures comparable data from different monitor systems. Two calibrations can be completed in one day. Hence, frequent regular or occasional fast emergency calibrations are feasible. The field results from this particular program highlight the need and feasibility for such field dynamic calibrations in any sampling network. - Authors' Abst.

811. Dutkiewics, J.S., Gallus, H.,Muzyczuk, J., Olpinski, W., and Tozmus, J.: Portable apparatus for determination of carbon dioxide, carbon monoxide, sulfur dioxide, and hydrogen sulfide. Med. Pracy (Lodz) 9:121-138, 1958.

A portable apparatus was developed for the determination of CO_2, CO, SO_2, and H_2S in the air and conditions were established for its operation to enable in accuracy averaging 0.0001% by vol. The apparatus served for detection of small concentrations of the above-mentioned toxic gases. In table 3 in the text the author gives the results of 2 tests, in mg./1. The H_2S content ranged from 0.22 to 5.42 and from 0.23 to 5.47; the SO_2 ranged from 0.25 to 5.02 and from 0.47 to 10.01. - APCA

812. Eaves, A., and Macaulay, R.C.: Sulfur Dioxide Pollution: Statistical Analysis of Results from Adjacent Lead Dioxide and Hydrogen Peroxide Instruments. Warren Spring Lab. Res. Rep. Dec. 1963.

Over a period of four years 829 pairs of readings were obtained at twenty sites. These readings were analyzed by using regression techniques. Although correlation between instrument readings at the same site is generally of great significance, the differences in the correlations from site to site show that no universally applicable calibration between lead dioxide and hydrogen peroxide instruments exists. Pairs of instruments at various sites can be calibrated by use of the particular site regression, but although the correlation may be highly significant, variances are still so large that, in most cases, that reliability is very poor.

813. Falk, L.L.: Reduction of sulfur acid fumes. Am. Indust. Hyg. A. Quart. 12:162-164 (Dec.) 1951.

In one step of the process for the manufacture of titanium dioxide pigment, large quantities of acidic gases are released in a very short period of time. These gases contain sulfuric acid mist and droplets, some SO_3 and SO_2, and large quantities of steam. A Schutte-Koerting jet scrubber was installed to scrub the sulfuric acid constituents from the attack gases, the peak scrubber operation being timed to the period of maximum gas evolution. The water scrubbing medium is neutralized to prevent corrosion and the creation of a water pollution problem. The equipment, with proper operational and maintenance precautions, has operated satisfactorily, resulting in an effluent consisting of saturated air with minor amounts of acidic constituents with no carry-over of acid mist or acid-wetted ore particles. - Author's Abst.

814. Fiber filters for fine acid mist. Brit. Chem. Eng. (London) 4:137 (March) 1959.

Terylene fibers formed into a pad 2 in. thick are reported to form a virtually perfect filter for fine particles of sulfuric acid mist. The high efficiency of the filter action is thought to be due to the fine diam. of the fibers and their hydrophobic character which results in dropwise collection of fine liquid particles. Elements based on this type of pad may be pre-formed into candles or flat discs. The filter is self-compensating over a wide range of gas-flow rate and mist loading. If the acid droplets are likely to attack the terylene fibers or the silicone surface of the glass wool, the gas must be passed through a humidification unit to dilute the acid. The fiber diams. range from 5 to 50 μ, but the effective operation depends on the correct choice of distribution of these diams. - APCA

815. Field, J.H., Brunn, L.W., Haynes, W.P., and Benson, H.E.: Cost Estimates of Liquid Scrubbing Processes for Removing Sulfur Dioxide from Flue Gases. USDI, BMRI 5469. 58 pp. (Aug.) 1959. Washington, D.C.

Capital and operating costs have been estimated for removing sulfur dioxide from flue gases of a powerplant of 120,000-kw. capacity by liquid-purification processes, using limestone, ammonia, or sodium sulfite as the reactant. Ammonia and sodium sulfite processes yield end products that may be marketable. Coals containing about 1.5 and 5.0% sulfur have been considered. The sulfur dioxide content of the gases to be treated is 0.083 and 0.30% respectively. Estimates have been made for 90% removal of the sulfur dioxide from both gases. A third instance has been considered in which 70% of the sulfur dioxide is removed from the flue gas of 0.30% concentration. Capital investment and operating costs, with no credit for products, are lowest for the limestone process for gases of both concentrations. Crediting the ammonium sulfate and sulfur produced in the ammonia process at their market prices at the end of 1956 of $32 and $28 respectively, the operating costs of the ammonia process become the lowest for purification of the gas containing 0.30% sulfur dioxide. The operating costs of the sodium sulfite process for purifying gas of high sulfur dioxide content approach those of the limestone process when the byproduct sulfur dioxide is credited at $14 per ton. Even if credit for products is allowed for the ammonia and sodium sulfite processes, the operating costs are higher than those of the limestone process for the gas of low sulfur dioxide content. Because of the large quantity of materials that would be produced by removing sulfur dioxide from a relatively small number of plants, credit for products should be allowed with extreme caution. - Authors' Sum.

816. Fielder, R.S., Jackson, P.J., and Raask, E.: Determination of sulfur trioxide and sulfur dioxide in flue gases. J. Inst. Fuel 33:84-89 (Feb.) 1960.

The apparatus described is easy to operate, compact, and portable. Measurements can be made at an average rate of 1 every 15 to 20 min. The turbidimetric technique is simple and is more sensitive than previously published methods, its precision, at similar concentrations, is comparable with the best of these. The successful use of this apparatus and analytical procedure in some thousands of measurements in power stations have shown that this is a convenient and reliable test method for the determination of sulfur oxides in flue gases in the lower temperature passes of boiler plant. The simplicity of the apparatus and the analytical method have made it possible to establish, for the 1st time, the determination of sulfur trioxide in flue gas as a routine technique of power station chemistry. - APCA

817. Fielder, R.S., and Morgan, C.H.: An improved Titrimetric method for determining sulfur trioxide in flue gas. Anal. Chim. Acta 23:538-540 (Dec.) 1960.

The measurement of SO_3 concentrations in the range 0-50 ppm. v/v in the presence of 2000-3000 ppm. v/v of SO_2 is usually carried out in 2 stages: (1) quantitative absorption of the SO_3 from a sample of flue gas in an aqueous solution of isopropanol which inhibits oxidation of SO_2, (2) determination of μg. quantities of SO_3 in the aqueous isopropanol. In most techniques described, sulfate in the aqueous isopropanol has been determined turbidimetrically; this technique possesses limited sensitivity and precision, and is rather time-consuming. The titrimetric method is quicker, more precise, and more sensitive than the turbidimetric method, which it would replace with advantage; it requires less manipulation and the reagents used are stable over long periods. The titrimetric procedure could be used to complete the flue gas analysis at the sampling site and is suitable for routine application to industrial plant. - APCA

818. Fletcher, A.W.: Improved apparatus for the determination of sulfur trioxide in gases. Chem. Indust. pp. 303-304 (April 28) 1956.

In the Corbett method used previously the flue gases are bubbled through a solution of isopropyl alcohol in water. A sulfuric acid mist forms in the flask containing the solution and is retained by a sintered glass filter. A turbidimetric method is then used for the determination of sulfate in the alcohol solution and in the washings from the filter. In the improved method now described, the flue gases do not bubble through the solution but flow through 2 sintered glass filters which are wetted by a flow of the solution from above. This method is simpler to use and it is easier to obtain reproducible results with it. - APCA

819. Foran, M.R., Gibbons, E.V., and Wellington, J.R.: The measurement of atmospheric sulfur dioxide and chlorides. Chem. in Canada 10:33-41 (May) 1958.

This paper describes the method used for measuring the relative "activity" of sulfur dioxide at Canadian exposure sites and reports the values obtained over a period of three years. The lead peroxide method was used and factors affecting its variability and correlation with volumetric measurements were investigated in detail at one of the sites. It is concluded that the lead peroxide method is particularly well suited for use in exposure studies at outdoor sites. The methods used for measuring atmospheric chlorides are discussed; the most promising is a modification of the "wet candle" method and use of rainfall cans. The chloride levels obtained during 1956 at a number of locations in the Halifax area are given. In addition brief reference is made to the performance of two standard metals which have been exposed at each of the sites to provide a measure of the relative corrosivity of the atmosphere. - APCA

820. Frazier, H.D., and Kohl, A.L.: Selective absorption of hydrogen sulfide from gas streams. Indust. Eng. Chem. 42:2288-2292, 1950.

It is frequently desirable to remove the hydrogen sulfide completely from a gas stream without removing a major portion of the carbon dioxide. This paper describes a process for accomplishing this result by use of solutions of methyldiethanolamine. Laboratory and pilot plant data presented show that the selectivity of these solutions is due to both a large difference in the absorption rates of the two acid gases and an equilibrium which favors the absorption of hydrogen sulfide. The latter property is unexpected in view of the greater acidity normally attributed to carbon dioxide. A gas-treating pilot plant is described and data are presented relative to operation under a wide range of conditions from 45 to 750 pounds per square inch gage and with inlet gases containing from about 4 to 50% acid gas. The methyldiethanolamine has been used both in aqueous solution and in conjunction with diethylene glycol as a combination treating-dehydrating system. Process described was found to offer distinct advantages over processes used currently for certain applications, particularly when a concentrated stream of hydrogen sulfide is desired for conversion to sulfur or sulfuric acid. - Authors' Abst.

821. Fusaroli, A. and Foschi, A.: The determination of sulfur dioxide in the atmosphere. Riv. Combustibili 11:167-177, 1957 and Chem. Abst. 51:11623 (Aug. 10) 1957.

Simple methods involving relatively little expense such as absorption in bubbling (Cauer) tubes followed with titration or that of Blanc, et al. (nephelometric) (C.A. 49, 15631) are recommended for use in research on atm. pollution in Italy. For special cases the use of automatic app. such as the Thomas may be required. - PHEA

822. Gasiorowski, K.: Sulfur removal from waste gas by the Pauling method. Mitt. V.G.B. (April) 1963, 2 pp.

This paper describes the Pauling method for SO_2-containing gases which is based on the liquid catalysis principle. One can count with 100% efficiency in regard to SO_2, if the process is correctly set up. These gases, containing SO_2, are passed through a bed of granular catalyst in the reactor. The SO_2 in the waste gases is absorbed by the catalyst and oxidized with residual oxygen to SO_3, during passage through the bed. Then, the SO_3 is being condensed together with water vapor to form dilute H_2SO_4 which is being withdrawn at the reactor bottom.

823. Gerarde, H.W.: Toxicological studies on hydrocarbons, VII. A gravimetric method for the determination of inorganic and ethereal sulfate in urine. Am. Indust. Hyg. A. J. 21:511-514 (Dec.) 1960.

A rapid simplified gravimetric method has been described for the determination of inorganic and total sulfates in urine. The procedure is suggested as a clinical method for the determination of the urinary sulfate ratio. The analysis can be carried out by a technician in the clinical laboratory since it does not require the specialized equipment of the analytical laboratory or the skills and experience of the analytical chemist. A new rapid quantitative self-regulating pressure filtration technique has been developed for this procedure, which may find wider application in analytical work in which filtration is required. - APCA

824. Gildenskiold, R.S.: Maximum permissible concentration of carbon bisulfide in the atmospheric air of residential districts. Gig. i Sanit. 24:3-8, 1959 and Bull. Hyg. 34:1026 (Oct.) 1959.

The field experience with the previously accepted maximum permissible concentrations of carbon bisulfide in the atmospheric air (the maximum concentration at one - 0.5 mg/m^3; the daily average concentration - 0.15 mg/m^3) has shown that these values were too excessive. These standards have been checked experimentally and new maximum permissible concentrations of carbon bisulfide have been established on hygienic bases. The threshold value of smell sensation for carbon bisulfide in the most sensitive persons comprises 0.05 mg/m^3. The reflex action by the method of optic chronaxy and adaptation to darkness, has been obtained with threshold values of 0.04 mg/m^3.

On the basis of these investigations the authors recommend to accept 0.03 mg/m^3 as the maximum permissible concentration of carbon bisulfide in the atmospheric air. The examination of the atmospheric air in the vicinity of an artifical Viscose fiber plant, devoid of any air purifying installations, has shown the air to be heavily polluted with carbon bisulfide within the radius of 1000 m (0.04 mg/m^3) with the spreading of gas to a distance of 3000 m (0.03 mg/m^3). - English Sum.

825. Gillespie, R.J., and Cole, R.H.: The dielectric constant of sulfuric acid. Trans. Faraday Soc. 52 (Pt. 10): 1325-1331, 1956.

The static dielectric constant of 100% sulfuric acid has been measured using a bridge circuit and a condenser in which the electrode separation could be varied in order to eliminate the effect of the large electrode polarization capacity. The static dielectric constant was found to be 101 at 25° and 122 at 8° in good agreement with the work of Brand, James and Rutherford. - Authors' Abst.

826. Gregor, M., Kachanak, S., and Prokop, V.: Selective desulfurization of waste gases from viscose cell-wool factories with mobile absorbing substance. Chem. Tech. (German) 14:139-143, 1962.

On the basis of health hazards, material balance, and theoretical considerations a method and the equipment necessary for a factory prepg. 10,000 tons cell-wool per year are described for the selective sepn. of H_2S and CS_2 from flue gases. H_2S is first removed from the wet flue gas by an oxidizing chemisorption on granulated S. The satd. S can be utilized for prepn. of H_2SO_4. Residual flue gas is dried and CS_2 adsorbed phys. on activated charcoal (I). The satd. I, freed of occluded O by means of an inert gas, is steamed to remove CS_2. The moist I is air dried and returned to the adsorption cycle. The mixt. of H_2O and CS_2 is condensed and utilized. This process is economical with a concn. of CS_2 of 1 g./cu.m. in the flue gas and the odor of the exhaust gases is not objectionable. - PHEA

827. Gustafsson, L.: Determination of ultramicro amounts of sulfate as methylene Blue-I, The color reaction. Talanta 4:227-235, 1960.

Sulfate may be determined spectrophotometrically as methylene blue after reduction to sulfide, which is allowed to react with *p*-aminodimethylaniline and ferric iron to form the dye. This paper deals with the color reaction.

The standard method for the color development proposed is founded on an investigation of the following variables: hydrogen sulfide losses, acidity at reaction and measurement, reagent concentrations, temperature at reaction and measurement, concentration of traces of heavy metals, time, and air-oxidation. Previously found deviations from Beer's law are confirmed and discussed. The yield of the reaction is determined. - Author's Sum.

828. Hall, H.J.: Trends in electrostatic precipitation and industrial gas cleaning. Chem. Eng. Progress 59:67-72 (Sept.) 1963.

Author reviews recent developments and trends in electrostatic precipitation, performance and application in the steel and chemical industry. Other trends in electrostatic precipitation include: operation at higher gas velocities (above 6 to 8 ft./sec.) to reduce size, to lower costs, and to improve gas flow distribution, improved automatic electrical equipment, and continuous ash removal systems without large storage hoppers.

829. Hands, G.C., and Bartlett, A.F.F.: A field method for the determination of sulfur dioxide in air. Analyst 85:147-148 (Feb.) 1960.

Authors describe a field method for determining SO_2 in air utilizing test papers impregnated with an ammoniacal zinc nitroprusside reagent. The test paper is placed in a holder and a known amount of air is drawn through the paper at a rate not exceeding 6 ml. per second. In the presence of SO_2, a brickred stain is produced. For quantitative determinations, the color is compared with standard stains or with standard discs.

When a volume of 360 ml. of air is used for analysis, SO_2 may be determined in concentrations of from 1-20 ppm with an accuracy of about ± 20%. Concentrations outside of these limits may be measured by increasing or decreasing the size of the sample. Details for preparation and storage of the test papers are given.

830. Heaney, R.J., and Starr, C.P.: Comparative equipment for atmospheric sampling of sulfur, fluorine, and dustfall. Am. Indust. Hyg. A.J. 23:296-303 (July-Aug.) 1962.

This paper reports on development and use of a single enclosure which incorporates sampling equipment for sulfur, fluorine, and dustfall. Comparisons between established procedures with new or modified techniques are made. Results obtained using "grease pans" for dustfall are compared to those using an adhesive paper. Factors are developed correlating average parts per million of sulfur dioxide with milligrams of sulfur absorbed on a lead-peroxide coated canvas. Milligrams of fluoride absorbed on lime-coated filter papers, using the old or new type sampling enclosure, are compared. Statistical analyses were used to determine any significant variances. - Authors' Abst.

831. Hein, L.B., Phillips, A.B., and Young, R.D.: Recovery of sulfur dioxide from coal combustion stack gases. In: Mallette, F.S. (editor): Problems and Control of Air Pollution. Reinhold Publishing Corp., New York, 1955, pp. 155-169.

The present work demonstrated that the ammonia scrubbing process can be used to recover a large percentage of the sulfur dioxide in stack gas from the combustion of high-sulfur coal. The process is operable over a fairly large range of conditions, which should make it easy to control and should permit variation of the process for a specific installation. Absorption coefficients calculated from experimental results indicate that fairly short scrubbing towers are adequate. Virtually complete utilization of ammonia was demonstrated.

832. Heitmann, H.G., and Sieth, J.: Sulfur removal from flue gases. Mitt. V.G.B. (April) 1963, 2 pp.

This paper describes methods used by the Siemens-Schuckertwerke, employing either metal oxides or carriers saturated with iron oxides. As a result of chemical reaction, catalysis and adsorption, sulfur oxides are taken up in amounts far exceeding the stoichiometric ratio of iron oxide and sulfur dioxide. When sufficient air is present SO_3 is being formed. Reaction begins at about 450°C.

833. Herrmann, G.: Easily portable apparatus for the rapid determination of SO_2 traces in air based on the pararosaniline method. Chem. Tech. (Leipzig) 15:342-348, 1963.

A portable self-contained apparatus for determining SO_2 trace amounts in air is described. Sulfur dioxide is adsorbed by suction into a freshly prepared solution of pararosaniline hydrochloride and formaldehyde. The extinction value of the solution is being measured against a standard and stable colour filter (1:1.7 Bengal Pink/Supracen Violet 3R on gelatin).

834. Herrmann, G.: Determination and preparation of low concentrations of sulfur dioxide in air. Z. Chem. 2:42-50, 1962.

A review is presented of methods for the determination of SO_2 in air and of techniques for preparing known concn. of SO_2 in air for the calibration of instrumental procedures. - PHEA

835. Hickey, H.R., Jr.: Studies on Two Types of Lead Peroxide Cylinders for Monitoring Atmospheric Sulfur Dioxide. In partial fulfillment of the requirements for the degree of Master of Science in Engineering. University of Florida, Feb. 1962.

The customary static sampling technique for monitoring atmospheric sulfur dioxide employs a mat of cotton gauze and lead peroxide affixed to suitable form, usually cylindrical. Precision in fabrication is difficult, and the true mass transfer area is unknown.

A modified version was developed which held promise in improving precision and facilitating fabrication by application of paint-like coatings to glass cylinders, without cloth support.

In field and laboratory comparisons, the modification exhibited a saturation effect when relatively little reagent had reacted, and failed to respond in proportion to concentrations of sulfur dioxide as did the customary type. - Author's Abst.

836. High, M.D., and Horstman, S.W.: Field experience in measuring hydrogen sulfide. Presented at the Am. Indust. Hyg. Conference, Cincinnati, Ohio, May 6-10, 1963.

Air pollution is a matter of major public concern in many communities in which kraft process pulp mills are located. Such is the case in the Lewiston, Idaho-Clarkston, Washington area. To better define the problem in that area and to seek its solution, a cooperative study was conducted by the States of Idaho and Washington, local agencies and the U.S. Public Health Service. Since hydrogen sulfide is one of the air pollutants associated with operation of kraft pulp mills, its measurement was included in the plan of investigations. The opportunity was taken to compare several methods of measurement by simultaneous use in a field setting.

1. Measurements of hydrogen sulfide in the ambient atmosphere using the methylene blue procedure and the lead acetate impregnated filter paper method described herein yielded results which, in general, were in close agreement.

2. Stains of lead sulfide produced by hydrogen sulfide on lead acetate impregnated filter paper did not fade significantly during an 8-week period beginning 1 to 4 weeks after sampling when filters were stored in tightly closed paper bags which had been coated on the inside with a vapor-moisture proof thermoplastic (Food freezer bags).

3. Low ambient air temperature did not affect results obtained in measuring hydrogen sulfide with the lead acetate impregnated filter paper method, when using a sample air stream that was humidified.

4. Use of air pumps which gave either steady or pulsating rates of air flow gave comparable results when hydrogen sulfide was determined by passing air through lead acetate impregnated filter paper.

5. Silver tarnishing as measured by light reflectance was found to be a useful tool in determining relative concentration of hydrogen sulfide at various locations and for determining adverse affects of hydrogen sulfide on silverware. Samples should be annealed after preparation and reflectance should be measured daily. The method can probably be calibrated so that it would also quantitatively indicate air concentrations of hydrogen sulfide. - Authors' Sum.

837. Hissink, M.: Determination of SO_3 and SO_2 in (Flue) gases. Chem. Weekblad 58:460-462, 1962.

The method of Zijden is used. Gas samples are drawn from flues with a probe consisting of an elec. heated glass tube fitted in a steel tube, and connected to the app. The samples are led at 2 l./min. for 30 min. through a G1 glass filter cone kept in a tube furnace at 200-250°, a G4 glass filter cone at a temp. between the dew points of H_2SO_4 and H_2O where H_2SO_4 formed from the SO_3 is trapped, through a wash bottle with 3% H_2O_2 to absorb SO_2, a drying tower with silica gel, and a distribution tube connected with a vacuummeter, a thermometer, and a rotameter. The SO_3 content is detd. to about 5 ppm. In calibrations 93-106% (av. 101%) of the SO_3 was recovered, with a standard deviation of 3.7%. For SO_2 these were 93-113% and 6.5%, resp. The app. is calibrated with a gas-mixt. obtained by addn. of a 6 l./hr. air current at 250°, and addn. of SO_3 and H_2O formed at 600° from a known H_2SO_4 aq. flow. The mixt. is homogenized by heating to 350°, in a tube of 40 mm. diam., with 6 partitions, which have a center 13 mm. The app. in which the gases are mixed can also be used to study the influence of dust in flue gases, to calibrate the dew point meter and study the connection between acid dew point and SO_3 content, and for corrosion expts. with metals and building materials. - PHEA

838. Hissink, M.: An instrument for determining sulfur oxides in flue gases. J. Inst. Fuel (London) 36:372-376 (Sept.) 1963.

A portable instrument for the accurate and simultaneous determination of SO_3 and SO_2 in flue gases has been developed. The instrument operates by cooling the sampled gases to a temperature between acid and water dewpoint and collecting the condensed mist of sulfuric acid in a G_4 glass filter. The SO_2 is absorbed in hydrogen peroxide solution. The sampling period is about 30 min. and the analysis is finished by 2 simple acid titrations. The performance of the instrument has been checked with the aid of an apparatus for the preparation of a stream of synthetic flue gas of known composition. The results showed a good agreement when the SO_3 content was in the range of 5-40 ppm. by vol., while 600-1000 ppm. of SO_2 was present. No interference from components normally present in flue gases has been found. - APCA

839. Hochheiser, S.: Manual and Automatic Methods of Atmospheric Sulfur Dioxide Measurement; a Critical Review and Methods Selected for Possible Standardization by Division of Air Pollution. USDHEW, PHS, RATSEC, (May) 1962.

This is the first of a series of evaluative reviews of available analytical technology pertaining to the measurement of the common gaseous and particulate pollutants found in the ambient air.

A critical review of the literature pertaining to the manual and continuous automatic sampling and analysis of sulfur dioxide is herein reported. Seventeen manual methods are evaluated. Prior to the selection of a manual method or methods, a set of proposed criteria were developed. The two tentative methods which best approach these criteria are: (1) West and Gaeke. (2) Hydrogen Peroxide.

Ten instrumental methods for the continuous sampling and analysis of atmospheric sulfur dioxide are evaluated. Selection of a tentative recommended automatic sampling and analysis apparatus was based upon conformance to instrument performance requirements as proposed in the "Criteria for Evaluation." The apparatus suggested in the recommended method utilizes the electroconductivity detection principle. Although no single commercial analyzer, currently available, incorporates all of the features specified in the recommended apparatus, these specifications can be met by modifications to existing sulfur dioxide analyzers. Electroconductivity instruments which are susceptible to minor modifications resulting in conformance to the performance criteria specified are: 1. Davis Electroconductivity Analyzer. 2. Thomas Autometer. 3. Beckman SO_2 Analyzer. 4. Mervyn-Cerl Automatic SO_2 Recorder. - From Author's Sum.

840. Hoffmann, G.: Hydrogen sulfide scrubbing from coke-oven gas with deacidified and concentrated ammonia liquor. Gas-u. Wasserfach (Munich) 99:509-514, 1958.

H_2S can be scrubbed from coke-oven gas by short-time contact with NH_3 liquor, without elevated pressures, and with good efficiencies. In order to remove more H_2S than corresponds to the NH_3 produced in the ovens, it is necessary to regenerate the NH_3 scrubbing solution. The most important cost factor in this regeneration is the steam cost; this increases with increasing dilution with water, and can be reduced by using more concentrated NH_3 solutions. The higher concentrations of the solutions lead to corrosion; this can be controlled by the use of Al and of Ci-Cr-Mo alloys. An appreciable cost reduction can be realized in H_2S removal from coke-oven gas by concentrated NH_3 solutions. - APCA

841. Hopton, G.U.: Removal of hydrogen sulfide from coal gas by means of iron oxide. The Gas World (London) 128:538-544, 1948.

This paper summarizes the findings of investigators in the gas industry, examines methods in purification techniques and gives a review of the literature.

842. Huygen, C.: Sampling of sulfur dioxide in air with impregnated filter paper. Anal. Chim. Acta 28:349-360 (April) 1963.

A method is suggested for the sampling of SO_2 in air with impregnated filter paper instead of bubblers. The best aqueous impregnating solution contained potassium hydroxide with glycerol or triethanolamine. The possibilities and limitations of the method are discussed. High collection efficiencies, over 95%, were obtained at relative humidities above 25%. Collected SO_2 was stable for at least several weeks when the filters were kept dry after the sampling. The method is especially suited for short-time measurements for automatic sampling with smoke samplers. - APCA

843. Jacobs, M.B., Braverman, M.M., and Hochheiser, S.: Ultramicrodetermination of sulfides in air. Anal. Chem. 29:1349-1351 (Sept.) 1957.

Hydrogen sulfides and other sulfides can be determined in the part per billion range in air if the air is bubbled through an absorption mixture of an alkaline suspension of cadmium hydroxide contained in a Greenburg-Smith impinger. Rates as high as 1 cfm can be used, or 0.1 cfm with a midget impinger. The concentration of the trapped sulfide is then estimated by the methylene blue method. Procedures for use both in the laboratory and in the field are detailed. - Authors' Abst.

844. Jacobs, M.B.: Techniques for measurement of hydrogen sulfide and sulfur oxides. In: Lodge, J.P., Jr. (editor): Atmospheric Chemistry of Chlorine and Sulfur Compounds. Nat. Acad. Sc. Nat. Res. Council. No. 652:24-34, 1959.

Sulfur-bearing components are among the most important air pollutants. The principal sulfur-bearing atmospheric pollutants are SO_2, SO_3, H_2SO_4, and H_2S. A number of methods have been devised for the detection and determination of hydrogen sulfide in industrial atmospheres for industrial hygiene purposes, such as lead acetate test papers and the hydrogen sulfide detector. These methods are not sufficiently sensitive for air pollution control work. Among the methods that have found some application in the determination of hydrogen sulfide as an air pollutant are the cadmium sulfide method and the methylene blue method. In the filter paper method, specially prepared filter papers are used for trapping the H_2SO_4, the sulfuric acid aerosol. The acidity can be determined by titration. Sulfur dioxide does not interfere in this method. - APCA

845. Jara, V. et al.: Recovering sulfur dioxide from combustion gases. Czech P. 1961.

A process based on the absorption of SO_2 in an aqueous solution of $(NH_4)_2SO_3$ is described. The unusual feature of this process is that combustion gases are first cooled by scrubbing with a mineral oil and the warm oil is then mixed with the saturated absorption solution to effect its recovery and to free the SO_2. After the end of decomposition the mineral oil is separated from the absorption solution and both returned, respectively, into the cooling and absorption system to be used in the next cycle. From each 100 weight parts of combustion gas the oil absorbed volatile ashes, 0.02 which are removed by filtration in the form of a suspension containing ashes and oil, 1:2 was used as fuel.

846. Johswich, F.: Removing sulfur from flue gas. Importance and practical possibilities. Brennstoff-Warme-Kraft (Dusseldorf) 14:105-115 (March) 1962.

Providing chimneys and removing sulfur from fuels, a method not practicable with all types of fuel, are not sufficient to prevent the increasing accumulation in the atmosphere of toxic sulfur compounds. As a result, some methods of gas cleaning are becoming indispensable. A critical review of the fundamental proposals indicates that additives and wet washing are generally unsuitable. Of the dry methods using absorption or adsorption, the latter appear to have most chance of success with regard to technical application and economic possibilities. So far, of the available adsorbents only active carbon seems to be suitable despite its high cost. The development of a new process has resulted in making the use of active carbon reasonably economical, and, therefore, permits a wider application of flue gas cleaning. For the sake of simplicity the approx. calculations and estimates which are included in the paper have been done for fuel oil only. With certain alterations they apply also to solid and other fuels. - APCA

847. Karolyi, J., Zalai, A., Birthler, R., and Spitzner, H.: Results of the second large-scale test of the Varga Process. Internat. Chem. Eng. 3:597-603 (Oct.) 1963.

The desulfurization of gasolines and diesel oils derived from high-sulfur crudes has become common in recent years. In many countries there is also a demand for sulfur-free fuel oil distillates. The desulfurization of heavy fuel oils is not considered economical at this time, but before long it will be necessary to solve this problem also.

The Varga hydrocracking process desulfurizes diesel oils and fuel oil distillates to a high degree. It does so economically, in one step and at medium pressures. It also effectively reduces the amount of sulfur-containing heavy fuel oil. Thus it combines two of the most important beneficiating processes of the petroleum industry: refining and the cracking of heavy oils.

The process has been run in the laboratory and in the pilot plant, using a variety of raw materials. From an industrial standpoint, however, the large-scale production tests are the most important ones. The first of these was conducted in 1956 and the results were subsequently published (Varga, J., and Tsai: Petrol Refiner 36:198, 1957, and Birthler, R., and Tsai: Brennstoff Chem. 36:348, 1958 and Erdol u. Kohle 11:71, 1959.) The second large-scale test was performed in 1960. - Authors' Abst.

848. Keerigan, J.W., Snajberk, K., and Anderson, E.S.: Collection of sulfuric acid mist in the presence of a higher sulfur dioxide background. Comparison of the electrostatic precipitator, the Greenburg-Smith Impinger, and the Sintered-Glass Filter. Anal. Chem. 32:1168-1171 (Aug.) 1960.

The electrostatic precipitator, the Greenburg-Smith impinger, and the sintered-glass filter are evaluated as to their efficiency in collecting sulfuric acid mist when a higher sulfur dioxide background is present. The results show that these instruments yield reproducible results over the concentration range of 0.5 to 150 mg. of sulfuric acid mist per cubic meter, and that these instruments are as efficient at low as at high concentrations. This study establishes the ability of these instruments to collect sulfuric acid mist accurately at concentrations found in the atmosphere under field conditions. - Authors' Abst.

849. Kennaway, T.: The Fulham-Simon-Carves process for the recovery of sulfur from flue gases. J. APCA 7:266-274 (Feb.) 1958.

The development and present state of the Fulham-Simon-Carves process are described. The process consists essentially of scrubbing the flue gases with ammonia liquor derived from gas works or coke oven plants. The resulting solution of ammonium sulfate, sulfite, bisulfate, and thiosulfate is then converted by autoclaving into ammonium sulfate and sulfur. Estimates of the cost of the process in its present stage indicate that the revenue from the sale of the products should compensate for the cost of installation and operation of the plant if the coal contains 1.5% of sulfur.

850. Kettner, H.: The removal of sulfur dioxide from flue gases. WHO Regional Office for Europe, Eight European Seminar for Sanitary Engineers, Brussels, Oct. 2-9, 1962.

Wet processes involving water-scrubbing, with and without additives, like the Battersea Power Station process, the Howden ICI Cyclic Lime process, the ammonia liquor process and other systems, have proved to be inadequate because of the cooling of the exhaust gases and their resultant loss of buoyancy; the main disadvantage of this is that the scrubbed gases may settle in the immediate vicinity of the plant and cause more nuisance than they would do if they had not been cleaned. Wet processes are, in addition, relatively expensive. Dry processes have a better chance of removing the noxious SO_2 from flue gases and three of the processes recently developed in Germany are described.

The Reinluft process uses low-temperature coke for the adsorption of the sulfuric oxides (SO_2 and SO_3); the SO_3 is first removed, at 200°C, then the SO_2 at 100 - 120°C. The ability of the coke to adsorb SO_2 is about the same as that of the best activated charcoals. The desorption by hot boiler gases takes place at 400°C, at which point some reactions between the water, carbon and SO_3 occur. As a result of these, the SO_2 gained is in the form of a 40 to 50% mixture by volume.

In the pre-burner desulfuration process, the sulfur-containing oil is burnt with one-third of the theoretically-needed quantity of air. The resultant H_2S is made to react with $CaCO_3$ at 1000 to 1200°C and CaS results. The CaS is again converted to $CaCO_3$ by CO_2 from the effluent gases, while the H_2S goes to a Claus reactor.

In the desulfuration in the burner-flame process a special activated dolomite powder is injected through six to eight jets directly into the flame. At this high temperature (1600°C) the sulfur in the oil reacts with the dolomite to form $MgSO_4$ and $CaSO_4$. Fe_2O_3, always present in the dolomite, works here as an oxidizing catalyst. The resulting $MgSO_4$ dust is removed by a high-efficiency electrostatic precipitator. - Author's Sum.

851. Killick, C.M.: The determination of atmospheric sulfur dioxide. The possibility of using potassium dichromate. Warren Spring Lab. Res. Rep. AP/60 Aug. 1962.

A method for the determination of atmospheric sulfur dioxide by catalytic reduction of potassium dichromate has been proposed and compared with the D.S.I.R. hydrogen peroxide method of analysis. The comparison was generally favorable, however, discrepancies were observed occasionally. These discrepancies did not appear to be correlated with air temperature or concentrations of oxides of nitrogen, but there was slight evidence of negative correlation with concentrations of ozone.

852. Killick, C.M.: Atmospheric sulfur dioxide by the hydrogen peroxide method: Data from two sites six feet apart. Warren Spring Lab. Rep. Aug. 1962.

Concentrations of sulfur dioxide at two sites six feet apart were analyzed for differences. The duration of observation extended over a period of two months. During a preliminary investigation of a proposed new method for atmospheric sulfur dioxide based on the reduction of potassium dichromate, data were obtained by the normal D.S.I.R. hydrogen peroxide method for these two sites. Tables and figures show the basic data and analyses of the differences which could be due either to instrumental variability or to genuine differences in the concentrations at the two sites, or to both. When the former contribution has been assessed by separate experiments, the latter will be able to be deduced and should provide useful data for the planning and interpretation of surveys of sulfur dioxide.

853. King, R.A.: Economic utilization of sulfur dioxide from metallurgical gases. Indust. Eng. Chem. 42:2241-2248, 1950.

The peculiar conditions regarding the dispersion of smelter smoke at Trail are outlined, and the development of the various sulfur-recovery processes employed is traced, with mention of the technical and economic considerations involved. The Trail smelter is located in a mountainous area where topographical and meteorological conditions are unfavorable for adequate dispersion of the sulfur dioxide contained in metallurgical waste gases. Expansion of the smelter output in the middle 1920's resulted in some atmospheric pollution, and proximity to the United States border lent international complications. Many of the developments were based on integration of new plants with existing ones and utilization of by-product materials from established operations. The availability of ammonia made possible its employment as an absorbant for sulfur dioxide. The acidification process for releasing sulfur dioxide from the absorbing solution was practical because a supply of sulfuric acid was at hand and the company was already producing and marketing ammonium sulfate. By-product oxygen made possible operation of the sulfur dioxide reduction process, and later the availability of by-product oxygen and substantially pure sulfur dioxide made possible the development of the cyclic process of sulfuric acid manufacture. The 15 years prior to 1943 witnessed the development of processes and installation of fertilizer plants at Trail, with the result that sulfur dioxide has changed from a waste material to a valuable raw material in short supply. To meet the demand for acid for fertilizer production, roasting of iron concentrates for acid recovery became necessary in 1943. At present all roaster and sintering plant gas is treated for sulfur recovery, and iron concentrate is roasted intermittenly, depending on the demand for acid and the availability of customs zinc concentrates. Total current loss to the atmosphere from Trail operations is less than 9% of the sulfur charged. The sulfur released to the atmosphere annually in 1947 and 1948 was less than in any other year since 1904. - Author's Abst.

854. Kingsley, K.: Analytical methods used in air pollution study. Indust. Eng. Chem. 44:1383-1388 (June) 1952.

This review of analytical methods used in air pollution study, particular reference can be made to the variety of techniques employed in general pollution surveys of recent years. It seems clear that fuller value from such surveys could be derived by use of standard techniques permitting cross comparison of findings from center to center. The A.S.T.M. committee in the United States, and such endeavors elsewhere, deserve full encouragement in this work of critical evaluation and standardization.

Air pollution investigations in which effects on health are concerned stand at a difficult stage. Donora perplexes the field with its acute respiratory episode in the presence of subphysiological levels of common irritants. It is evident that advances in knowledge of toxicological safe limits are needed. Of equal importance, however, is basic research on the physico-chemical relationship between particulates and the gases of urban atmospheres. The Los Angeles study, particularly, has shown that an urban atmosphere is a chemical system of diverse and energetic activity. Laboratory studies on the thermodynamics and chemistry of such systems may be the prior requirement in establishing the choice of pollutants which should be estimated in the complex environments on which future study may be undertaken. - Author's Concl.

855. Kitano, Y., and Takakuwa, H.: Determination of hydrogen sulfide and sulfur dioxide in air. 1. Errors in iodemetry. Japan Analyst 3:7-10, 1954.

Following suggestions were made to avoid errors in the iodometric determination of hydrogen sulfide and sulfur dioxide in air. An absorbing tube containing sodium theosulfate solution should be connected through a ground glass joint to the iodine tube in order to trap escaping iodine while air is being bubbled. Distilled water and starch indicator should be previously treated with iodine. The iodine tube should be cooled to 0° to reduce evaporation of iodine.

856. Knop, W.: Hydrogen sulfide and pure air requirements. Zentralblt. Arbeitsmed. u. Arbeitsschutz 11:1-5, 1961.

The dry and wet processes used in destroying H_2S emitted into the atmosphere are being mentioned and compared with newer methods which are described in detail. Such as: Methods developed by the Phrix industries; by the Spinfaser plant; the so-called Giammarco-Vetrocoke-Method, and also the active coal method (Aktivkohlen-Verfahren) of the Lurgi enterprise. Also the method to destroy H_2S by chlorinating is being described. All these methods should contribute considerably to the hygiene of the ambient air. - From German

857. Kobayashi, Y.: A rapid method for micro-determination of sulfur dioxide in air by means of a detector tube. Japan Analyst 9:229-232, 1960.

Present methods for determining small amounts of sulfur dioxide in air are inconvenient and time-consuming. For the rapid determination of SO_2, several granular gels which change colors when exposed to air containing small amounts of SO_2, were studied. A detector reagent consisting of purified silica gel impregnated with I_2 solution and tetramethyl-diamino-diphenylmethane, was found to have the highest sensitivity in the determination of SO_2 in the air. The gel was placed in a glass tube and the air sample drawn through the tube with a constant flow rate of 1 cc/sec., the quantitative estimation made possible by measuring the length of the colored portion of the column. The range of determinations studied were: (1) 5 to 300 ppm when the sample volume was 100 ml and feeding time 100 sec.; and (2) 1 to 40 ppm when the sample volume was 500 ml and feeding time 500 sec. The mean relative error of the method was below ± 5%. The proposed method and the colorimetric method are compared, and actual estimations by the proposed method are described. - Author's English Abst.

858. Kriege, O.H., and Wolfe, A.L.: The spectrophotometric determination of sulfur in iron alloys. Methylene blue method. Talanta 9:673-678, 1962.

Sulfur is determined in iron alloys by evolution as hydrogen sulfide, followed by reaction with N,H-dimethyl-p-phenylene-diamine and iron ^{III} to form methylene blue, which is measured spectrophotometrically. Replicate results are reported for acid soluble metal samples containing 0·3-230 ppm of sulfur. An evaluation of the accuracy of the methylene blue procedure was made using radiotracer techniques. - Authors' Sum.

859. Kristal, E., Dennis, R., and Silverman, L.: A study of a multiple Venturi wet collector. Proc. 49th Annual Meeting Air Pollution Control Association, Buffalo, N.Y., May 20-24, 1956.

An experimental model of a new type wet collector was investigated in the Harvard University Air Cleaning Laboratory at the request of the Division of Engineering of the U.S. Atomic Energy Commission.

This unit consists of single or multiple collection stages, each containing a Venturi tube and two spray generators. The principal collecting mechanism is the impingement of dust particles and water droplets in the spray chamber and in the Venturi tube where the saturated gas stream reaches a maximum velocity of 12,000 fpm. This unit is not directly comparable to the Pease-Anthony Venturi scrubber since, in the latter device, water is atomized by the main gas stream at the Venturi throat, whereas in the experimental collector water sprays are introduced in plenums prior to and following the Venturis. Furthermore, the pressure drop in a Venturi scrubber ranges from 20 to 40 inches of water (due to energy requirements of atomization) as compared to 12 inches of water for the four stage unit. The rapid expansion of the saturated gas stream taking place in the Venturi throat is stated by the manufacturer to produce cooling (Joule-Thomson effect), which results in condensation on the dust particles. This effective increase in particle size then allows the particles to be more readily removed.

A special feature of this collector is the spray generating device which uses mechanical means rather than air or water pressure to produce a fine water spray.

This report describes results of tests with representative aerosols under a variety of operating conditions. Dust concentrations varied from 2 grains per 1000 cubic feet to 2 grains per cubic foot and water rates from 6 to 12 gallons per minute per spray generator. Several combinations of spray generators were employed during multi-stage operation. - Authors' Introduct.

860. Kropp, E.P., and Simonsen, R.N.: Scrubbing devices for air pollution control. Paint Oil Chem. Rev. 115:11, 14 & 16, 1952.

Three main sources of air pollution are considered: acid treating of lubricating oil stocks (I) in which large quantities of SO_2 and some SO_3 are evolved, grease manufacture (II) in which unpleasant smelling fatty acids and H_2S are possible contaminants, and asphalt manufacture (III) in which the disagreeable portion of the fumes consist of hydrocarbon aerosols and vapor. Studies were made of these three process sources to determine a means of minimizing the nuisances. The batch nature caused release of contaminants to be periodic; the total amounts were not excessive and were not enough to warrant economical recovery. The program was one of converting the offending material into a form satisfactory for disposal. Low-pressure spray towers were ineffective in removing SO_2 from I and a survey of other scrubbing devices was made. An experimental fog-filter unit is described and previous workers' conclusions that a high degree of atomization of the scrubbing medium is necessary in cases of difficult absorption, was confirmed. A gauge pressure of physical dimensions and rated capacity of the filter unit are tabulated. A 3% solution of soda ash in water was used as the scrubbing medium. At a concn. of 10,000 p.p.m. of SO_2, an air rate of 1000 cu.ft. per min. and a spray rate of 20 gal. per min., the SO_2 concn. was reduced to 1 p.p.m. The same equipment was used experimentally for absorption of H_2S in II using 3% soda ash and 8% NaOH. The latter medium completely removed H_2S from air with an inlet concn. of 45,200 p.p.m. Fatty acid odors were removed using water as a scrubbing medium. The efficiency of an installed fume-disposal equipment in III was improved by reducing the steam concn. by means of water sprays.

861. Kuczynski, E.R.: Simplified method of calibrating SO_2 gas analyzers in the parts per million range. J. APCA 13:435-436 and 449 (Sept.) 1963.

This paper describes a simple method and equipment for calibrating gas analyzers in the parts per million range. Although it deals primarily with the Autometer-type equipment for measuring SO_2 in air, the method can be adapted easily for other type analyzers and other gases of interest.

862. La Mer, V.K., Inn, E.C.Y., and Wilson, I.B.: The methods of forming, detecting, and measuring the size and concentration of liquid aerosols in the size range of 0.01 to 0.25 microns diameter. J. Colloid Sc. 5:471-496, 1950.

(a) The objective of this research was to develop method of producing, detecting, and measuring rapidly and easily the size and concentration of liquid aerosol droplets in a range (0.01-0.08 μ) smaller than those at present available.

(b) The new contribution to the method of measurement of particle size consists in growing quantitatively exceedingly small aerosol droplets to a size range where they can be measured by established optical methods.

(c) Aerosol droplets with radii less than 0.08 μ are too small to be measured by any of the optical methods available. The electron microscope is not always suitable on account of the liquid character of the droplets and their volatility.

(d) The sizes of homogeneous aerosol droplets following controlled growth are easily measured by a variety of optical methods developed previously in the Columbia University Laboratories (under NDRC-OSRD contracts in 1940-45), for a size range terminating at the approximate lower limit of 0.08 μ radius, depending upon the index of refraction and the precision desired. The polarization of the scattered light furnishes the most sensitive measure in this range of size. As size is increased, measurement naturally becomes less difficult and more reliable. The various optical methods applicable in these upper ranges make contact with those of the ordinary light microscope.

(e) The homogeneous aerosol generator of La Mer and Sinclair can be used for the production of exceedingly small particles; 99% H_2SO_4 and dibutyl phthalate have proven to be suitable examples. The lower limit of size production appears to be the critical nucleus (radius$\sim 10^{-7}$ cm. or 0.001 μ); the smallest radius measured by the present growth is about 0.01 μ, although smaller sizes of the order of 0.006 μ are detectable and these sizes can be estimated crudely.

(f) Aerosols of 99% H_2SO_4 when exposed to H_2SO_4 solutions of higher water content absorb water, and grow to a size such that the aqueous tension of the droplet equals that of the master solution to which it is exposed. Vapor pressure equilibrium is attained exceedingly rapidly.

(g) Similar behavior is exhibited by dibutyl phthalate aerosol droplets when exposed to the vapors of volatile solvents such as toluene, xylene, etc. Theory indicates, and there is no evidence to the contrary, that all liquid aerosols when exposed to the vapors of a miscible and volatile solvent can be grown under controlled conditions.

(h) In the case of 99% H_2SO_4, measurements can be made following growth by a factor as large as 8-fold in radius (512-fold in volume or an increase in the intensity of light scattering of roughly 4000- to 250,000-fold, depending upon initial radius). The control of the growth is more reliable the smaller the growth. Five-folds is recommended.

(i) The number and radii of the grown sulfuric acid droplets were determined by the optical transmission method. The mass of H_2SO_4 thus calculated was compared with the mass deposited upon a filter which was washed, and the pH of the wash liquid was determined with a glass electrode. Considering the minute amount of material collected, satisfactory agreement was secured.

(j) The range and reliability of the transmission method was improved by generating new functions of the type K/a^n, where K is the optial scattering area coefficient, and a $=2nr/\Lambda$; n was varied from 1 to 3. These derived functions give characteristic maxima and minima in more desirable ranges of droplet radii. - Authors' Abst.

863. Landsberg, H. and Escher, E.E.: Potentiometric instrument for sulfur determination. Indust. Eng. Chem 46:1422-1428 (July) 1954.

An automatic instrument, the Titrilog, continuously records trace quantities of oxidizable sulfur compounds in the range of 0.1 to several hundred ppm by volume in gases and atmospheres. Coulometric titration with electrically generated bromine is used. Titration is electronically controlled at a potentiometric balance point. Various applications in the natural gas and air pollution fields are discussed. Hydrogen sulfide, sulfur dioxide, mercaptans, and other organic sulfur compounds, except carbon disulfide and carbon oxysulfide, can be determined by this method, but it does not distinguish between compounds. Olefins and other oxidizable non-sulfur compounds interfere only when present in high concentrations. Naturally free halogens and other strong oxidants interfere. - Authors' Abst.

864. Lang, W., and Mader, E.: Determination of hydrogen sulfide of inside air. Zeitschrft. Anal. Chem. 145:179-184, 1955.

A method to determine hydrogen sulfide in amounts of 10-30 µg is being discussed in this paper.

The gas is being absorbed in a diluted iodine solution and the H_2S amount is being calculated by colorimetric measurement of the decrease of the extinction or through titration of the surplus iodine with thiosulfate.

The other possibility is to collect the hydrogen sulfide in acid cadmium solution, to oxydize the cadmium sulfate with iodine and hydrochloride acid and to titrate the superfluous iodine with thiosulfate.

Hydrogen sulfide in amounts of 10-30 µg could be determined exactly up to ± 5% by titration. - Authors' Sum. Translated

865. Lawler, C.: Use of a sulfur dioxide scrubbing system in air pollution control. In: Mallette, F.S. (editor): Problems and Control of Air Pollution. Reinhold Publishing Corporation, New York, 1955, pp. 222-224.

The recovery system was originally developed by Cominco to remove sulfur dioxide from smelter sintering gas, as is now being done at Trail. This led to the application of the recovery system to sulfuric-acid plant tail gases, to which it is particularly well suited. We are presently studying the application of this process in the removal of sulfur dioxide from power plant stack gases. Results developed to date look very promising. Successful development in this field offers tremendous possibilities. - Author's Sum.

866. Lawler, C.: Air pollution control by a sulfur dioxide scrubbing system. J. APCA 7:29-30 (May) 1957.

This paper describes a process by which sulfur dioxide is removed efficiently and economically from waste gases. Its essential features are the reaction of the sulfur dioxide in solution with ammonia and the addition of sulfuric acid to convert the ammonium sulfite bisulfite to ammonium sulfate which is used as a fertilizer. The sulfur dioxide concentration in the exit gases is well below requirements. The process is automatic to a great extent.

867. Lawrence, E.N.: Integrated surface effects of atmospheric pollution. Nature 195:266-267 (July 21) 1962.

The lead dioxide candle method for measuring atmospheric SO_2 may have a number of applications to atmospheric pollution problems in general. Accumulation of sulfate on the cylinder (measured by P, the monthly mean daily number of mgm. of SO_3 collected by 100 cm.^{2} of PbO_2) is related to V (the monthly mean daily concentration, vol. of SO_2/100 million vols. of air), by $P = V\ (0.08\ \mu + 011)$ where μ is the mean wind speed in mph. The dependence of the PbO_2 gauge on wind speed is confirmed by windtunnel data. The PbO_2 equipment may also be used in problems of absorption of a gaseous pollutant by a horizontal ground surface, although the laws governing the physical processes involved are different from those of a cylinder exposed in a polluted air stream. - APCA

868. Laxton, J.W., and Jackson, P.J.: Automatic monitor for recording sulfur trioxide in flue gas. J. Inst. Fuel (London) 37:12-17 (Jan.) 1964.

A reliable and accurate automatic analyzer has been developed to determine concentrations of sulfur trioxide in flue gas down to about 0.5 ppm. v/v. The reaction between sulfate ions and the barium salt of chloranilic acid has been utilized in a simple colorimetric system to give continuous records for periods of several hrs. The present instrument has a normal full-scale range of 0.5 to 50 ppm. (v/v), but this can easily be varied to between 0.2 and 10 ppm. and 1 to 100 ppm. sulfur trioxide, precision of about 2% of the full-scale reading can be achieved over each working range. Readings are given every 45 sec., delayed for 3 or 4 min. by hold-up through the system. The instrument has been used in trials on power station boilers and on a small laboratory combustion unit, 2 gal./h^{-1} fuel oil; simultaneous check determinations made with manual apparatus and acid deposition probes have shown good agreement within the known limits of the techniques. - APCA

869. Lay, J.O.: Contribution of British standards to the control of air pollution. Fuel Econ. (London) 40:81-83, 1962.

The Committee on Air Pollution (Beaver Comm.) recommended that the British Standards Institution should prepare codes of practice indicating the extent to which smoke can be reduced with good practice and standard specifications for smoke indicators, recorders, and alarms. The B.S.I. has not only completed these tasks but has undertaken others such as the preparation of standard Ringelmann charts and the measurement of solids emitted from chimneys. A whole range of investigation has also been conducted in the domestic field. Measurement of smoke density, grit and dust emission, domestic appliances, smokeless fuels, smoke emission from domestic appliances and incinerator plants are discussed. - APCA

870. Lea, N.S.: Sulfur dioxide and heat recovery system for blow pit gases. Proc. 10th Pacific Northwest Industrial Waste Conference, Pullman, Washington, 1961, pp. 145-148.

The method used for the recovery of SO_2 and heat from the blow pit gases as practised at the Scott plant in Everett has proved itself an excellent and efficient system. Although its most important contribution has been the elimination of the public nuisance of discharging blow pit gases to the atmosphere, it has also resulted in substantial economic savings--savings far in excess of the cost of installing and operating the system. - Author's Concl.

871. Levaggi, D.A., and Feldstein, M.: A rapid method for the determination of sulfur in fuel oil by the Schoniger oxygen flask method. J. APCA 13:380 and 387 (Aug.) 1963.

Classic methods for the determination of sulfur in organic compounds generally involve combustion of the material and subsequent estimation of the sulfate formed. Most of the standard procedures require the use of complicated apparatus, considerable skill, and are generally time consuming. ASTM methods for sulfur are based on classic techniques requiring special apparatus and skills, and are also time consuming.

Schoniger introduced the oxygen combustion flask which has been used for the determination of a number of elements in organic compounds; a comprehensive review of the method and bibliography has been published.

This study was undertaken to determine the applicability of the Schoniger technique to the determination of sulfur in fuel oil.

872. Levine, B.S.(translator): Uzhov, V.N.: Sanitary Protection of Atmospheric Air Purification of Industrial Discharge Gases from Suspended Substances. U.S. Dept. of Commerce, Office of Technical Services, Washington, D.C., 1957.

Contents: Pt. I. Terminology, definitions, and rules related to the purification of emission gases from suspended particulate matter. Properties of gas suspensions. Methods of mechanical gas purification. Wet gas purification. Gas filtration. Electrical gas purification. New methods and apparatus for gas purification. Combination gas purifying apparatus. Pt. 2. Flue gases from heat and power stations and boiler plants. Elimination of ash from flue gases of large electric power and heat centers. Removal of ash from boiler plant flue gases. Purification of emission gases in plants of ferrous metallurgy. Purification of discharge gases of non-ferrous metallurgical plants. Purification of gases discharged by cement plants. Purification of gases discharged by the chemical industry. Purification of ventilation air from dust. Appendix. Bibliography. Note: Quantitative and qualitative properties of industrial emissions most frequently encountered, and formulas for the calculation of gas pollutant concentrations are presented. The basic principles of operation, designs, and construction of gas purifying equipment are illustrated and described in detail. Methods for the determination of efficiency of industrial gas purifying equipment are outlined. - APCA

873. Liddell, H.F.: Reagent for sulfur dioxide. Analyst 80:901 (Dec.) 1955.

A sensitive reagent to detect small quantities of sulfur dioxide in smog can be prepared by dissolving 0.1 g. of Astrazone Pink (Bayer) in 20 ml. of hot water, allowing it to cool, then adding a solution of 5g. of sodium bicarbonate in 50 ml. of cold water and 25 ml. of glycerol and making up to 100 ml. A drop on filter paper held between two sheets of transparent plastic, each with a circular hold 0.110 inch in diameter can be used in conjunction with a hand-operated gas sampling pump. The reagent will keep in the dark for about a week or the dye solution alone for several months. - Author's Abst.

874. Lodge, J.P., Jr., and Tufts, B.J.: Techniques for the chemical identification of micron and submicron particles. Tellus 8:184-189 (Feb.) 1956.

Chemical methods are presented for routine identification and size estimation of water- or acid-soluble particles of a number of chemical species, using spot test techniques and light or electron microscopy. Although the work reported here is primarily that of the authors and their co-workers, a brief literature survey of work in other laboratories is included. - Authors' Abst.

875. Lodge, J.P., Jr., and Xinteras, C.: Methods of analysis of polluted atmospheres in the U.S. Measurement of atmospheric soiling potential. Internat. J. Air & Water Poll. 7:79-90 (May) 1963.

This series of articles on methods of analysis of polluted atmospheres is intended to make more widely known practices which have been found particularly useful in the U.S. It is not intended to be a comprehensive review and the references are deliberately restricted to American literature and this journal. Some of the methods may already be well known to workers in this field. - Authors' Abst.

876. Lodge, J.P., Jr.: Measurement of sulfur trioxide. Internat. J. Air & Water Poll. 7:83 (May) 1963.

Sulfur trioxide, or sulfuric acid mist, is frequently cited as an important constituent of polluted atmospheres. There is no specific method for this material. All existing methods are to some degree indirect and depend on collection of the aerosol by a filter, electrostatic precipitator, or other sampling device. Such collection prevents subsequent interference by gaseous species. The subsequent methods of analysis can be divided into 3 groups: Those which test for the acidity of the sample and determine all acidic pollutants; those which measure the sulfate ion and suffer interference by all sulfate salts; and those depending on the resulting conductivity change, and measure all ionic pollutants. An informal survey of individuals engaged in air monitoring reveals that nearly all are using filter paper or electrostatic precipitators for collection, followed by titration or turbidimetric measurement of acid or sulfate. - APCA

877. Lubatti, O.F.: Determination of Fumigants. VIII. Determination of sulfur dioxide and sulfur trioxide from burning sulfur. J. Soc. Chem. Inc. 55:344-346T (Dec. 4) 1936.

(1) A macro- and a micro-method for the determination of sulfur dioxide are described. (2) A macro-method for the simultaneous determination of sulfur trioxide is described. (3) A stabilizer for sulfite, suited to these methods, is selected. (4) These methods are suitable for use with Page's vacuum apparatus for the measurement of gas concentration. - Author's Sum.

878. Ludwick, J.D., and Perkins, R.W.: Liquid scintillation techniques applied to counting phosphorescence emission. Measurements of trace quantities of zinc sulfide. Anal. Chem. 33:1230-1235 (Aug.) 1961.

An analytical procedure is based on electronically counting the individual phosphorescence photons following light-excitation for the measurement of scintillation grade zinc sulfide particles on molecular air filters. The zinc sulfide was collected on these filters during meteorological studies of particle dispersion. The analytical procedure involves dissolving a zinc sulfide laden filter in an ethyl alcohol-ethyl acetate solvent, exposing the sample to a fluorescent lamp, allowing the sample to decay (in the dark) for a predetermined time, then counting the phosphorescence photon emission. The counting equipment requirements are similar to those commonly used for counting tritium. The conditions of excitation and measurement yielded a sensitivity of about 10^{-8} gram. A sensitivity improvement of 1 to 2 orders of magnitude could probably be obtained by minor procedural changes. The precision of the zinc sulfide measurements on clean and dirty filters is about ± 3% and ± 6% standard deviation. Corrections for loss in counting efficiency on dirty filters are made from absorbance measurements with a colorimeter. - PHEA

879. Lysyj, I., and Zarembo, J.E.: Spectrophotometric method for the determination of small amounts of sulfur in organic compounds: A semimicro and micro method. Microchem. J. 3:173-180 (May) 1959.

A rapid colorimetric method for the determination of sulfur in organic compounds is described. The method is very general in scope and permits the determination of organic sulfur in the presence of other negative elements such as chlorine, phosphorus, and nitrogen, without cumbersome and time-consuming separations. It is possible to determine sulfur in semi-micro, micro, and trace amounts using essentially the same technique. - APCA

880. Macho, V.: Effect of sulfur and some of its compounds on the Oxo process. Internat. Chem. Eng. pp. 117-121 (Oct.) 1961.

Sulfur has a retarding effect on the Oxo process and reduces conversion of olefins to aldehydes. For example, when 0.20% by weight of cobalt, based on the weight of C_6-C_7 olefins, is used in the presence of 0.1% by weight of sulfur, conversion is about 42%, and with 0.2% of sulfur, conversion is no more than 12%. Using an equimolar amount of sulfur with respect to the cobalt present in the reaction medium, not only is conversion of olefins about 45%, but the product obtained contains no soluble cobalt carbonyls. By increasing the amount of cobalt, reaction rate and conversion increase linearly. Since sulfur restricts the formation of cobalt carbonyls, the optimum amount of the catalyst is determined also by the purity of the raw materials. The purer are the latter, the greater, up to a certain point, will be the rate and conversion of the Oxo reaction under otherwise identical conditions, or the smaller will be the amount of catalyst required to produce the same conversion.

An effect similar to that of elemental sulfur is shown by carbon disulfide. Oxonation is affected much less by ethyl mercaptan. Quantitative calculation of the relative adverse effects of sulfur, carbon disulfide, and ethyl mercaptan (on mole basis) gives the approximate relationship. $S:CS_2 : C_2H_5SH = 100:71:1.6$

Tetrahydrothiophene and thiophene, even when present in an amount of 5-7% based on the weight of olefins, do not retard or inhibit oxonation and do not lower conversion, and it may thus be concluded that compounds containing only thioether sulfur have practically no adverse effect on the Oxo process. Successful oxonation is hindered by elemental sulfur and sulfur compounds which are capable of attacking cobalt carbonyl under the reaction conditions of the Oxo process. - Author's Sum.

881. Magill, P.L.: Determination procedures. Am. Indust. Hyg. A. Quart. 11:55-63 (March) 1950.

The accurate measurement of impurities in an atmosphere is fundamental to any intelligent corrective measures that may be taken to eliminate the pollution. This paper describes some of the methods of determination that have been found to be effective in the investigation of smog in Los Angeles. The collection and analysis of particulate matter and gaseous atmospheric impurities are discussed. The use of the proton scattering technique as a new and useful tool for the analysis of minute samples is briefly described, as well as the direct photographic techniques for estimation of the properties of particulate matter in the open atmosphere. Some of the more common applications of these methods are mentioned, and a few of the many unsolved problems in instrumentation and measurement are outlined. - Author's Abst.

882. Marsh, J.D.F., and Newling, W.B.S.: Oxidation of hydrogen sulfide to sulfur dioxide. Fuel Abstracts 22:183 (Aug.) 1957.

Claim 1: - A process for treatment of hydrogen sulfide-containing gases by catalytic oxidation of the hydrogen sulfide substantially to sulfur dioxide only, which process comprises heating the gases containing at least sufficient oxygen to oxidize the hydrogen sulfide to sulfur dioxide, to 180° to 450°C, and bringing them into contact with a catalyst consisting of one or more sulfates of heavy metals, or metal oxide cations or oxides of metals superficially converted to sulfates of metal oxide cations. - PHEA

883. Massey, O.D.: Demisters for sulfuric acid plant stacks. Chem. Eng. Progress 55:114-118 (May) 1959.

This article is a condensation of a report presented at the Air and Water Pollution Abatement Conference, MCA, Cincinnati, March, 1959. A case history of unabsorbed SO_3 of sulfuric acid manufacturing facilities is reviewed. The most practical method found to absorb the gas uses a knitted wire mesh made of Carpenter 20 or Hastelloy C. Vessel dimensions, gas velocity, volumes, etc. are outlined. The article concludes that the relatively inexpensive FA-20 alloy appears, in general, to be the cheapest and most practical alloy for this service. - PHEA

884. McCaldin, R.O., and Hendrickson, E.R.: Use of a gas chamber for testing air samplers. Am. Indust. Hyg. A. J. 20:509-513 (Dec.) 1959.

This paper describes a gas chamber used to test air sampling equipment, and it reports on the collection efficiency and operating characteristics of three types of air samplers. One is a commercially available scrubber, another a sampler of special design, and the third a midget impinger. - Authors' Introduct.

885. McKinley, J.B.: The hydrodesulfurization of liquid petroleum fractions. In: Emmett, P.H. (editor): Catalysis Vol. V. Reinhold Pub. Corp., New York, N.Y., 1957, pp. 405-526.

Practically from the beginning of the application of hydrogenation processes to the conversion of petroleum fractions and coal into lighter products, it was recognized that hydrogenation was also effective for the simultaneously removal of oxygen, nitrogen, and sulfur compounds. The procedure was not economical for application to petroleum fractions because of the high cost of hydrogen and because the demand for low sulfur content petroleum products could be met by refining low-sulfur crudes or by alternate desulfurization methods. Recently, the widespread installation of hydroreforming with its tremendous quantities of by-product hydrogen has made commercial hydrodesulfurization operations feasible. The need for such commercial operations has simultaneously become more acute because of an increase in the amount of high-sulfur crudes which are being refined and the increasing demand for low-sulfur middle and heavy distillate fractions which cannot be prepared in a completely satisfactory fashion by other desulfurization methods.

The author considered the literature through 1955 together with a few references in 1956. There are 292 references.

886. Miller, F.E., and Kohl, A.L.: Here's a new solution for selective absorption of hydrogen sulfide. Oil & Gas J. 51:175-183 (April 27) 1953.

This paper describes results of a considerable amount of laboratory and pilot-plant work, and a commercial-scale test of 20 week's duration show methyldiethanolamine (MDEA) to be suitable material for the selective absorption of gases.

These tests by Fluor Corp., Ltd. show MDEA to have an appreciable selectivity for hydrogen sulfide in the presence of carbon dioxide. The aqueous and glycol-amine systems now employed use monoethanolamine (MEA) and diethanolamine (DEA). These solutions are essentially nonselective, both hydrogen sulfide and carbon dioxide being effectively absorbed from the gas stream.

The MDEA solution strips readily and does not display any unusual characteristics with regard to corrosion, foaming, or other operating factors.

Pilot-plant operations show that under optimum conditions, gas containing less than 0.25 grains hydrogen sulfide per 100 standard cubic feet can be produced by MDEA solutions, even at low operating pressures.

Initial studies consisted of simple laboratory tests on over 50 different absorbents. This was followed by bench-scale glass pilot-plant tests and finally by pilot-plant studies at pressures up to 750 psig. with amines which appeared to be the most promising solvents. Of the chemicals tested, methyldiethanolamine (MDEA) was found to offer the best combination of properties, and the greatest emphasis was placed on this material.

Upon completion of the test with MDEA, the plant has been gradually returned to a DEA system by the use of DEA makeup. To minimize solution contamination, a water wash has been installed ahead of the treating unit, and according to latest reports is doing a very satisfactory job in preventing any additional contaminating material from entering the treating plant solution. The principal reason for returning to DEA operation on this unit was the comparatively high cost of MDEA, 77½ cents per pound, as compared with 31¼ cents per pound for DEA. According to the manufacturer, if commercial application of this amine gains wide acceptance, the price will be reduced appreciably.

887. Moore, G.E., Cole, A.F.W., and Katz, M : The concurrent determination of sulfur dioxide and nitrogen dioxide in the atmosphere. Proc. Air Poll. Control A. 49, Paper no. 24, 1956.

Concurrent determinations have been made of low concentrations of sulfur dioxide by the conductimetric and fuchsin methods, and of nitrogen dioxide by the Saltzmann method, by means of three suitably adapted automatic impingers at a common atmospheric sampling point in Windsor, Ontario. Conductimetric determinations yielded consistently higher values for sulfur dioxide than the colorimetric method based on the chromogenic reaction of fuchsin, formaldehyde, and sulfite. These differences may be accounted for, in part, by the presence of nitrogen dioxide in the atmosphere which reacts with the fuchsin reagent to lower the colorimetric sulfur dioxide value. The nitrogen dioxide contents of the atmosphere fluctuate in a manner similar to those of sulfur dioxide and are somewhat lower in magnitude than the conductimetric sulfur dioxide levels. When the fuchsin values are corrected for the effect of nitrogen dioxide, the colorimetric sulfur dioxide levels are in fairly close agreement with those estimated by the conductimetric method. Data are presented to show the hourly variation in sulfur dioxide in the Windsor atmosphere. The nitrogen dioxide levels reported thus far are lower than those found in Los Angeles atmosphere. - Authors' Sum.

888. Moore, H., Helwig, H.L., and Graul, R.J.: A spectrophotometric method for the determination of mercaptans in air. Am. Indust. Hyg. A. J. 21:466-470 (Dec.) 1960.

The method described is quick and accurate and determinations may be made using apparatus common in air pollution and industrial hygiene work. The method determines total mercaptans and does not differentiate between individual mercaptans although it is most sensitive to the low molecular weight alkanethiols. H_2S, SO_2, and NO_2 do not interfere at the concentrations usually encountered in air pollution and industrial hygiene studies. - Authors' Sum.

889. Mrose, H.: Experience with the SO_2 analysis procedures of Zepf and Vetter in Wahnsdorf near Dresden. Ztschft. Gesmt. Hyg. Grenzgebiete 8:767-775 (Oct.) 1962.

The SO_2 content of the air at the edge of the city of Wahnsdorf, near Dresden, was measured over the period of March 1961 to Feb. 27, 1962, with the air of the slightly modified method of Zepf and Vetter. Measuring by means of a glass-bottomed frittered washing tube and a Pulfrich photometer was found to be easy and measurements could be carried out in a truck following adaptation to battery operation. The expenditure in chemicals used was very low. The possibilities of error and the accuracy of measurements are discussed. Content in the air could be measured down to $20\gamma/m^3$ and a proof could be supplied down to approx. $10\gamma/m^3$. The results obtained during the measuring period at Wahnsdorf revealed great variability of the individual values, depending on the wind direction, and a marked annual pattern. A 24-hr. sampling showed decided peaks of about $110\gamma/m^3$ at the 24th hr.; of slightly over 300γ at the 7th hr.; and of 410γ at the 10-11th hrs. On a monthly basis the lowest average reading was of about $15\gamma/m^3$ in June rising gradually until the 11th month when there was a drastic rise to 160 and 180γ respectively for the 11th and 12th month. The level dropped to around $120\text{-}150\gamma$ for the 1st, 2nd, and 3rd months, then dropped drastically to 25 and 20γ for the 4th and 5th months. - APCA

890. Munroe, W.A.: Automatic instrumentation for air pollution monitoring - a progress report on automatic directional air sampling. Am. Indust. Hyg. A. Quart. 17:298-302 (Sept.) 1956.

The directional air sampler discussed, has not yet been proved an effective tool for establishing the source of air contaminants. Experiences with the device have resulted in the definition of certain design criteria which should be met in future development of directional sampling. The need is great for pin-point monitoring procedures for official agency use. There appears to be ample justification for time and money spent on further exploration into this technique. - Author's Sum.

891. Nader, J.S., and Coffey, W.L.: Automatic zero drift correction of the titrilog. Am. Indust. Hyg. A. J. 24:563-567 (Nov.-Dec.) 1963.

The modified titrilog with increased sensitivity and automatic zero drift correction was calibrated with a known concentration of SO_2 in clean dry air contained in a 100 l. mylar plastic bag. Correction was accurate within ± 2% of full-scale with a predetermined position of the baseline on the recorder chart. The sensitivity was increased by a factor of 15 to give a calibration sensitivity of 1 pphm. of SO_2/recorder chart division. The sensitivity and time response of the modified system permit operation as a continuous, unattended monitor of SO_2 in the ambient atmosphere. The instrument responds to low concentrations in the pphm. range and to transient peak concentrations of several min. duration. - APCA

892. Napier, D.H., and Stone, M.H.: The collection and turbidimetric estimation of sulfur trioxide in flue gases. J. Appl. Chem. 8:787-793 (Dec.) 1958.

Increased precision of the turbidimetric determination of sulfur trioxide has been achieved by making refinements to a published technique and modifications to a commercially available instrument. The method has been improved by more careful control of several variables that affect the turbidity of barium sulfate suspensions. The improved method is applicable to solutions in the concentration range 1 to 80 mg./liter of sulfur trioxide, with a precision of ± 2% in the range of 6 to 80 mg./liter and a lower precision in the range of 1 to 6 mg./liter. A modified apparatus for absorbing sulfur trioxide from the gas sample is also described. This is more effective, more compact, and easier to use than previous arrangements of a similar type. - APCA

893. Nash, T.: Low velocity gas liquid impinger for the continuous estimation of sulfur dioxide and other atmospheric pollutants. J. Sc. Instruments 38:480-483 (Dec.) 1961.

The instrument records sulfur dioxide conductimetrically in the range 0.01 - 10 ppm where rapid changes in concentration can be expected but the accuracy required is not more than 1 in 20. Sampling is continuous and cumulative, with a return to initial conditions 2 or 3 times an hour. The principle of operation is the removal of a soluble vapor from an air jet impinging on to an unbroken liquid surface. One modification of the instrument measures light absorption instead of conductivity, permitting the use of colorimetric reagents. - APCA

894. Nash, T.: A "personal" measuring instrument for atmospheric sulfur dioxide. Internat. J. Air & Water Poll. 8:121-124 (Feb.) 1964.

The instrument was developed for the measurement of sulfur dioxide concentrations within the range of 0·1-5 ppm. It weighs about 1 kg complete with battery and solution. Readings are taken by squeezing and releasing a flexible bottle, which aspirates air into a small conductivity cell containing dilute hydrogen peroxide solution. Fifty or more readings can be taken on one charge of solution, each reading taking about one minute. - Author's Sum.

895. Nauman, R.V., West, P.W., Tron, F., and Gaeke, G.C., Jr.: A spectrophotometric study of the Schiff reaction as applied to the quantitative determination of sulfur dioxide. Anal. Chem. 32:1307-1311 (Sept.) 1960.

Ultraviolet and visible absorption spectra indicate that when HCl is added to pararosaniline, the decolorization occurs because of the formation of a trianilinium-chloromethane which has an absorption spectrum very similar to that of either toluene or triphenyl methane, both of which are colorless. The addition of sulfur dioxide in any available form in the presence of formaldehyde leads to the synthesis of a pararosaniline methyl-sulfonic acid which gives an absorption spectrum similar to that of pararosaniline, but which requires a higher acid concentration than does unsubstituted pararosaniline, for the formation of the colorless trianilinium form. As a result of these factors, the formation of the color of the pararosaniline methyl-sulfonic acid is considered to be the basis for the quantitative estimation of sulfur dioxide. The studies are significant because of the wide use of this reaction in the determination of sulfur dioxide in air pollution studies. - APCA

896. Nonhebel, G.: A commercial plant for removal of smoke and oxides of sulfur from flue gases. Trans. Faraday Soc. 32:1291-1297, 1936.

Simultaneous removal of smoke, dust and acid constituents from flue gases by alkaline water in compact commercial plant has recently been achieved as a result of study of packings for absorption towers. Such a plant is the Howden-I.C.I. grid packed gas washer, units of which were put into service at Swansea Power Station last year. Further units will shortly be in operation at the new Fulham Power Station. An account of this plant and process together with a survey of the problem of atmospheric pollution in large cities has already been given in Applied Science Journals. The physical and chemical problems involved in the design of the plant are, however, of general interest. - Author's Abst.

897. Offutt, E.B., and Sorg, L.V.: Analyzer-recorder for measuring hydrogen sulfide in air. Anal. Chem. 27:429-433 (March) 1955.

An instrument for measuring and recording hydrogen sulfide in air in the concentration range of 0 to 100 ppm has been developed for testing refinery atmospheres.

The instrument is based upon the use of special film prepared by coating blank 16-mm. motion picture film with buffered lead acetate. The sample is pumped continuously through an exposure hood, where the hydrogen sulfide reacts with the film coating to form a stain. The density of the stain is measured and recorded photometrically. A warning alarm sounds automatically when the hydrogen sulfide exceeds 25 ppm. The method and apparatus are described and a typical field test record is shown. - Authors' Abst.

898. Olivo, R.: Thomas autometer for measuring small amounts of sulfur dioxide in air. Points on its possible uses and limitations. Minerva Med. pp. 1015-1016, 1958.

While the sensitivity of the apparatus is 0.05 ppm. of sulfur dioxide, any gas dissolving to give an electrolyte will register as sulfur dioxide. Readily absorbed gases include sulfur dioxide (98 to 99%), hydrogen chloride, hydrogen fluoride, and ammonia. Less readily absorbed are nitrogen oxides, carbon dioxide, hydrogen sulfide (of which 25 ppm register as 0.15 ppm sulfur dioxide), and sulfuric acid aerosols. - APCA

899. Paccagnella, B., and Fontanella, E.: Atmospheric pollution by metals measured polarographically. Igiene Mod. (Parma) 49:1093, 1956.

An investigation of pollution by metals, sulfur compounds and fluorine in the vicinity of a glass manufacturing and working plant was made, following several cases of acute poisoning. A polarographic method was used for determining heavy metals, including copper, lead, zinc, and cadmium, a colorimetric method for determining iron using sulfo-cyanide, a gravimetric method for sulfur compounds, and the madder lake-zirconium method for fluorine. The results show the existence of amounts of these substances which are considerably less than the generally accepted tolerable limits. Hypotheses as to possible synergistic action, formation of toxic products of interaction, etc. are considered. - APCA

900. Parker, A.: The removal of sulfur dioxide from flue gases. Smokeless Air J. Nat. Soc. Clean Air pp. 101-102, 1957.

The ammonia process has been studied at the Fuel Research Station by experiments in the laboratory, including determinations of equilibrium vapor pressures of sulfur dioxide and ammonia in contact with solutions of ammonium salts in various concentrations, and by trials with pilot plants supplied with flue gas. In the pilot plants the flue gas has been treated at rates of flow of about 1,000 to 25,000 cubic feet per hour; and data were obtained to assist in designing a large pilot plant to treat 1 or 2 million cubic feet per hour at a power station. To remove more than 90% and obtain a solution rich in ammonium salts, it is necessary to scrub the gas in two or more stages. In one series of experiments, the gas was scrubbed in two stages with a strong solution and then with a weaker solution. Under these conditions 95 to 98% of the sulfur dioxide was removed from flue gas containing only about 0.06% of sulfur dioxide by volume; the loss of ammonia in the treated gas was from 3-8% of the ammonia added as gas liquor. Other experiments are discussed as well as the economics involved. - APCA

901. Pate, J.B., Lodge, J.P., Jr., and Neary, M.P.: Use of impregnated filters to collect traces of gases in the atmosphere. II. Collection of sulfur dioxide on membrane filters. Anal. Chim. Acta 28:341-348 (April) 1963.

HA and AA millipore filters impregnated with 5% potassium bicarbonate and dried were found to be suitable for sampling concentrations of SO_2 in air. The impregnation technique and filter loadings are described. Flow rates are relatively unaffected by impregnation. The apparatus and procedures used for preparation and sampling concentrations of SO_2 in air are also described. Comparisons of actual and theoretical concentrations in the 0.1 to 10 ppm. range showed that the concentrations prepared must be assayed. The collection efficiency of impregnated filters was evaluated for sodium tetrachloromercurate-(II) less than 10% of which is in contrast with the 100% efficiency found with TCM as a scrubbing solution, and potassium bicarbonate (greater than 95%). The capacity of the filters was such that sampling a 10 ppm. sample for 1 hr. is possible. - APCA

902. Pate, J.B.: Methods for the estimation of sulfur dioxide. Internat. J. Air & Water Poll. 7:80-83 (May) 1963.

Methods commonly used for estimating SO_2 may be divided into 3 types: monitoring, cumulative, and short-term methods, each type yieldig a different kind of information. Since any or all of the kinds of information may be required in a given situation, a preferred method for each type is described in detail. The methods selected were to produce measurements which could be compared. - APCA

903. Patterson, G.D., Jr., and Mellon, M.G.: Determination of sulfur dioxide by color-changing gels. Anal. Chem. 24:1586-1590 (Oct.) 1952.

A gel sensitive to sulfur dioxide can be prepared from about 2 ml. of silica gel and 20 ml. of saturated ammonium vanadate at pH 5.5 to 8.5. Other active gels were also prepared. The gel is placed in a glass tube and air is drawn through it. As little as 10 ppm of sulfur dioxide can be determined. The resulting colors can be interpreted (1) by measuring the length of colored gel, (2) by comparing the color with standard color cards, or (3) by determining the volume of air required to produce a desired color. Hydrogen sulfide and hydrogen chloride also produce color effects which interfere, and ammonia has a bleaching effect. - Authors' Abst.

904. Paulus, H.J., Floyd, E.P., and Byers, D.H.: Determination of sulfur dioxide in atmospheric samples. Am. Indust. Hyg. A. Quart. 15:277-282 (Dec.) 1954.

A comparison of a colorimetric and polarographic method for determination of sulfur dioxide in atmospheric samples is given. As a result of this study a comparison of the sensitivity of the two methods for SO_2 has been made, the reproducibility of each determined, and the extent of their agreement shown. The methods have about equal reproducibility (± 2%). When compared to each other consistently lower results (2%-7%) were obtained by the polarographic method for actual atmospheric samples. It is believed that the explanation for the consistently low results by good agreement when analyzed by the two methods. It is believed, though not experimentally proved, that the discrepancy between the methods when applied to atmospheric samples is due to tautomerism of sulfurous acid or an unidentified interference. A portable-type filter photometer suitable for field use was found to compare most favorably with a more expensive laboratory-type spectrophotometer for the colorimetric determination of sulfur dioxide. - PHEA

905. Pearce, S.J., and Schrenk, J.H.: Determination of sulfur dioxide in air by means of the midget impinger. USBMRI 4282, 1948.

A rapid and convenient method for determining hygienically significant concentrations of sulfur dioxide in air is described based on the time required to decolorize an iodine-potassium iodide-starch solution in the flask of a conventional midget impinger. The method gives satisfactory results in concentrations as low as 2 p.p.m. It is not specific and hence is applicable only in atmospheres where sulfur dioxide occurs in the absence of other reducing or oxidizing gases. - Authors' Sum.

906. Peregud, E.A., Bykhovskaia, M.S., and Gernet, E.V.: Rapid Methods for the Determination of Toxic Substances in the Air. Moscow, Goskhimizdat 1962, 272 pp.

The methods outlined are grouped under 3 large chapter headings: Methods for obtaining samples of air containing one or more toxic substances. Methods for the determination of toxic substances. Gas analyzers. The methods, about 45 of them, are mostly colorimetric and are for substances such as ammonia, oxides of nitrogen, carbon disulfide, hydrogen sulfide, sulfur dioxide, and ozone. Some simplified air analyzers, together with those using optic, thermal-chemical, and electro-chemical methods are discussed. The appendix is in 4 parts, mostly tabulations of data and information for converting volumes to standard conditions of temperature and pressure. There is also a subject index. - APCA

907. Phillips, R.J., and Napier, H.G.: Sulfur is recovered by new process. Petrol. Ref. 36:151-154, 1959.

The first commercial Electrostatic Desulfurization plant was placed in service for Cities Service Oil Company at their East Chicago refinery during October, 1958. Subsequent testing showed that the plant easily met all process requirements, with the sulfur content of the treated product averaging less than 25 ppm sulfur. The unit was similarly effective in removing arsenic. The new process employs a technique described as "electrostatic mixing" to greatly enhance reaction efficiencies. Authors' Sum.

908. Pinaev, V.A.: Lime for removing sulfur dioxide from gases. Ref. Zh. Khim, 1962.

A procedure for removing sulfur dioxide from exhaust gases by using lime is discussed. The chief advantages of the described method are stated: possibility of purifying hot and dust-laden gases without first cooling and removing the dust; use of a cheap raw material; low capital investment; possibility of automation. The relatively high hydraulic resistance of the scrubber is a disadvantage of this procedure.

909. Powell, A.R.: Recovery of sulfur from fuel gases. Indust. Eng. Chem. 31:789-796, 1939.

Since the inception of the manufactured gas industry, hydrogen sulfide has been removed from the gas before it is distributed to consumers. This purification of city gas was necessary chiefly because combustion of most unpurified fuel gases leads to excessive production of sulfur dioxide or trioxide and this might be detrimental to health, comfort, or property of those consumers burning the gas in flueless appliances. Until comparatively recent years no commercial attempt was made to recover the removed sulfur as a useful by-product in this country, although in Europe utilization of the recovered sulfur has been common practice for many years. However, within the last fifteen years much progress has been made in the United States and today the recovery of sulfur as a useful by-product from coke-oven gas, water gas, refinery-still gas, natural gas, and other fuel gases is a rapid growing industry. The recovery and utilization of this by-product offsets at least a portion of the expense of purification, and under some favorable conditions even leads to a net profit, the value of the recovered sulfur being greater than the total cost of purifying the gas. Processes for recovery as elemental sulfur, for recovery as hydrogen sulfide and miscellaneous processes are discussed.

910. Purcell, P.R., and Williams, T.H.: The Extraction of Sulfur from Coke-Oven Gas and the Manufacture of Sulfuric Acid. Proc. Air Pollution Meeting -- Iron and Steel Inst. London (Sept. 25-26) 1957. Special Rept. No. 61, 1958, pp. 56-61.

This paper describes the plant installed at the Corby coke-ovens for the desulfurization of coke-oven gas by the Collin ammonia process and the production of sulfuric acid from the recovered hydrogen sulfide by the Chemiebau wet contact sulfuric acid process. Operation of the plant is discussed and modifications which have been incorporated are described, and recent developments of the process are reviewed. - APCA

911. Rampacek, C., and Clemmer, J.B.: Sulfuric acid from sulfur dioxide by autoxidation in mechanical cells. USBMRI 1963, 24 pp.

The technical feasibility of producing dilute sulfuric acid by autoxidation of sulfur dioxide gas from pyrite roaster or waste smelter gas, are demonstrated by batch and continuous tests. Iron and manganese salts were used as catalysts.

912. Reed, E.L.: The removal of sulfur dioxide from flue gas. Smokeless Air, Autumn 1963, pp. 44-45.

The author reviews methods for control of sulfur dioxide from flue gases such as the C.E.G.B.-Battersea, Howden-I.C.I., and Fulham-Simon-Carves processes. The Reinluft Process is being investigated at the Warren Spring Laboratory and final results are not expected for some time.

Also discussed are the threshold limits of low and ground-level values of sulfur dioxide.

913. Rose, H.J., and Glenn, R.A.: Cleaning coal for industrial uses. Coal Utilization 13:23-28 (Sept.) 1959.

Sulfur content of steam-plant fuels is of interest because of the relation to plant maintenance costs, thermal efficiencies, and air pollution problems. Existing methods for the removal of sulfur oxides from fuel stack gases are prohibitive in cost, so that the possibilities of removing a greater proportion of the sulfur from fuels before combustion, warrant reexamination. Extensive research is continuing in this country and in England on the technical and economic feasibility of processes which have been suggested for removing sulfur dioxide from stack gases from the combustion of sulfur-containing fuels. Another approach to the problem is to locate new electric generating facilities at a distance from metropolitan areas, and thus disperse the sources of stack gas emission. Continuing developments in high-voltage transmission are increasing the practicability of this approach in various areas. - APCA

914. Sawyer, D.T., George, R.S., and Rhodes, R.C.: Polarography of gases - quantitative studies of oxygen and sulfur dioxide. Anal. Chem. 31:2-5 (Jan.) 1959.

An exploratory investigation has been made of the polarographic behavior of chlorine, bromine, oxygen, sulfur dioxide, nitrogen dioxide, nitrous oxide, hydrogen, carbon monoxide, hydrogen sulfide, and hydrogen cyanide. A plastic membrane is used as the diffusion barrier for the working electrode. For many of the gases half-wave potentials and fusion current for a gas is proportional to its partial pressure, in the gas phase or dissolved in solution. The method is effective for the concentration range of 0.01 to 100% (by volume). Table. - PHEA

915. Schwarz, O.: Views and work on sulfur removal from flue gases. Mitt. V.G.B. 83:67-71 (April) 1963.

Statistics of production, consumption and costs of sulfur produced in Western Germany are discussed in this paper. In order to determine which dry method of sulfur removal is most suitable, the best adsorption or absorption material for SO_2, and the possible disposal of sulfur, laboratory scale tests are being conducted. Total sulfur content in hard coal consists of: 57% organic, 41% pyritic, and 2% sulfate sulfur.

916. Scorer, R.S.: An effect of gas washing at Battersea power stations. Smokeless Air, Autumn 1955, pp. 26-28.

The gases of the washed plume have a negligible buoyancy and pass away from the chimney top almost horizontally; while those of the adjacent untreated plume rise at an angle of anything between 5° and 30° to the horizontal on account of their buoyancy, and probably give rise to no objectionable concentrations anywhere. The washed plume loses enormous amounts of heat as it mixes with the surrounding air on account of the evaporation of the liquid water droplets suspended in it. The argument in favor of gas washing is based upon the assumption that sulfur dioxide in the amounts produced at a large power station are obnoxious and that a process which removes 95% of it must be beneficial. Because the washed plume descends to the ground so close to the station, even if 95% were removed, the concentration of sulfur dioxide at the ground is much greater than if no washing had been performed. - APCA

917. Seidman, E.G.: Determination of sulfur oxides in stack gases. Anal. Chem. 30:1680-1682 (Oct.) 1958.

A rapid, sensitive method for determining trace amounts of sulfur trioxide in gases is developed. Sulfur trioxide is absorbed in 80% isopropyl alcohol solution and titrated with barium chloride. A modification is used for determining total sulfur oxides. Ammonium and nitrogen oxides do not interfere.

918. Sensenbaugh, J.D., and Hemeon, W.C.L.: A low-cost sampler for measurement of low concentration of hydrogen sulfide. Air Repair 4:5-7, 25 (May) 1954.

Hydrogen sulfide is an air pollutant, whose primary nuisance effects are in the slow tarnishing of silverware and in the blackening of house paints containing lead pigments, at concentrations much below those producing a health hazard and those noticeable by odor. The instrument described is designed to measure such concentrations. It is a modification of the A.I.S.I. automatic smoke sampler. Two supplementary features are required: (1) removal of the black solids prevalent in ordinary air, and (2) preparation of an impregnated filter paper tape to give an intense color change proportional to the hydrogen sulfide concentration. The means for accomplishing these purposes are described. Fading of the sample spots occurs to some extent within a few days, but the fading is insignificant when the readings are recorded each day. Evaluation of the concentrations is described. Typical hydrogen sulfide concentrations are given from outdoor sampling over 8 months. About 95% are less than 0.005 ppm, and 0.1% over 0.030 ppm. The sensitivity of the instrument is reduced when the relative humidity of the air is low. It can be remedied by humidifying the air in the sampling train. - Authors' Abst.

919. Shelton, R.D., Nielsen, A.H., and Fletcher, W.H.: The infrared spectrum and molecular constants of sulfur dioxide. J. Chem. Physics 21:2178-2183 (Dec.) 1953.

By means of an infrared prism-grating spectrometer equipped with a multiple-path cell, seventeen vibration-rotation absorption bands of SO_2 have been observed and recorded. Seven bands exhibiting rotational structure were analyzed for the rotational constants of the upper and lower vibrational states. Harmonic and anharmonic constants in the vibrational energy expression have been calculated, and suitable values for the force constants in a four-constant potential function have been obtained. No bands ascribable to $S^{34}O_2^{16}$ were found. - Authors' Abst.

920. Silverman, M.P., Rogoff, M.H., and Wender, I.: Removal of pyritic sulfur from coal by bacterial action. Fuel (London) 42:113-130 (March) 1963.

The development of practical methods of decreasing the sulfur content of coal is of great importance, especially in relation to atmospheric pollution by SO_2 from the combustion of coal. Lowering the sulfur content of coal also decreases fireside deposits and corrosion problems in the combustion of coal, and low sulfur coke in the manufacture of steel. Bacterial action was most effective with small particle sizes of coal and more than 80% of the pyrite was removed in some cases. The sulfur in coal exists as sulfates, inorganic sulfides (pyrite or marcasite), and organic sulfur compounds. The relative ease of coal desulfurization followed the order bituminous > sub-bituminous > lignite owing to the acid neutralizing capacity of the lower rank coals. Pretreatment with acid increased the susceptibility of all coals, except 1 lignite, to bacterial desulfurization. The addition of ferric sulfate increased pyrite removal from all acid-treated coals. A mechanism for pyrite removal by bacteria is discussed. - Authors' Abst.

921. Smelting sulfides in suspension. Chem. Eng. News 33:1966 (May 9) 1955.

International Nickel of Canada is using a new oxygen flash-smelting process to treat all of its copper sulfide concentrates. The flash-smelting furnace gas is water scrubbed and treated by a wet Cottrell before it is converted into liquid sulfur dioxide by Canadian Industries (1954) Ltd. The production of liquid sulfur dioxide involves drying the cleaned gas with sulfuric acid and then compressing and cooling it to condense the sulfur dioxide. Last year approximately 70,000 tons of liquid sulfur dioxide were produced for use by the Canadian Sulfite Pulp Industry as well as about 65,000 tons of 100% sulfuric acid. - Author's Abst.

922. Smith, A.F., Jenkins, D.G., and Cunningworth, D.E.: Measurement of trace quantities of hydrogen sulfide in industrial atmospheres. J. Appl. Chem. 11:317-329 (Sept.) 1961.

Although methods have been published for the measurement of traces of H_2S in air, no mention is made of their reaction to SO_2, which is invariably present in the atmosphere, particularly in industrial areas, in concentrations vastly in excess of that of the H_2S. In some cases, the calibration and ultimate limits of detection of the methods are also in doubt. The work described here includes a critical practical appraisal of 5 alternative methods with respect to interference by SO_2, maximum flow rate and limit of detection and their accurate calibration to low levels by both volumetric and gas dilution techniques. Modification to eliminate interference by SO_2 are also described.

A description is given of a simple portable field apparatus capable of measuring concentrations of H_2S down to 10^{-4} p.p.m. in a 2 h. sampling period, together with typical levels found when using it. - APCA

923. Smith, B.: Quantitative Analysis of Mixtures of Hydrogen Sulfide and Sulfur Dioxide. Trans. Chalmers Univ. Technol., Gothenburg, No. 150 1954, 19 pp.

The recovery of sulfur from gases containing hydrogen sulfide is described. Efficiency of the Clauss oven and subsequent sulfur recovery are estimated by determinations of hydrogen sulfide and sulfur dioxide in the exhaust gases. The methods of Winkler and Lunge did not give reliable results when both gases were present, because a side reaction occurs with deposition of sulfur when water vapor is present. An improved Winkler method, however, was found to give good results. Numerous runs with synthetic mixtures of the two gases and air proved that the method gives reasonably accurate results for the simultaneous determination of sulfur dioxide and hydrogen sulfide. - Author's Abst.

924. Snowball, A.F.: Air pollution control at cominco operations. Chem. Canada 10:42-44 (May) 1958.

Air pollution control methods developed and in use at the Trail, B.C., smelter of the Consolidated Mining and Smelting Company of Canada, Limited, are described. Sulfur dioxide, which in the 1920's escaped into the air and caused claims for crop damage, is now used profitably in the production of sulfuric acid. Now all forms of pollution, whether solids, liquids, or gases, are subject to control. Measurement of all substances detrimental to the supply of pure air is carried out continuously at more than 100 stacks and vents. The concentrations of potentially dangerous pollutants are then monitored or measured at various distances from the source. A continuous record is kept of concentrations at certain locations many miles from the plants. Since dispersion is greatly affected by the weather, a weather station is operated. With these procedures, any possible nuisance or damage to vegetation, animals, or persons can be assessed. The numerous tests used are described briefly. Standards are set for all stack emissions and are derived by the results of several years' normal operation. Smoke abatement equipment includes modern types of baghouses and wet scrubbers. Some processes, such as the manufacture of ammonium phosphates, nitrate, and sulfate call for special technical treatment. Each problem of air pollution has to be studied on its own conditions. The cost of equipment can be very high where large volumes are concerned and is often a major obstacle in any program of industrial air pollution abatement.

925. Spengler, G.: The development of cleaning methods for sulfur dioxide by using coal and fuel oil. Staub 23:171-175 (March) 1963.

No method is known at the present time which assures the prevention of emissions of sulfur oxides and at the same time is economical in operation.

This paper surveys methods and possibilities available at present. Desulfurization of coal and fuel oil, the addition of additives to the combustion process, gasification of fuels and the influence of stack heights are outlined.

From the multitude of cleaning methods for smoke gas only those in use are being described in detail or those which are of technical significance. Several wet processes are also described in detail. The absorption and adsorption methods of dry processes are discussed. - Author's Abst. Translated

926. Stalker, W.W., Dickerson, R.C., and Kramer, G.D.: Atmospheric sulfur dioxide and particulate matter. A comparison of methods of measurements. Am. Indust. Hyg. A. J. 24:68-79 (Jan.-Feb.) 1963.

In addition to providing comprehensive monitoring data to support the medical phase of the study, the results of these measurements have been used for various aerometric evaluations previously reported. In this paper the experience and results of the study are applied to: (1) Test the significance of differences and analyze variance of measurements obtained by 2 or more methods of concurrent sampling. (2) Determine various interrelationships between atmospheric sulfur dioxide and particulate matter. (3) Present relative advantages and disadvantages of certain methods of sampling for selected pollutants. Comparison of the results obtained from great numbers of samples using several different methods of measuring both ambient sulfur dioxide and particulate matter indicated that 2 different concurrent standard methods of measuring a single pollutant may give significantly different average results. - APCA

927. Stang, A.M., Zatek, J.E., and Robson, C.D.: A colorimetric method for the determination of sulfur dioxide in air. Am. Indust. Hyg. A. Quart. 12:4-8, 1951.

A method of analysis for sulfur dioxide for in-plant and outdoor air by the simple addition of one reagent to a portion of the collected sample is described. The sample is collected with the all-glass standard or midget impinger using a sodium hydroxide solution with a glycerine solution added as an oxidizing inhibitor. The color reaction is accomplished by the addition of 2 ml. of color reagent of fuchsin in the presence of formaldehyde and concentrated sulfuric acid. Light interference is eliminated during the analysis by the use of darkened flasks. Interference was found with hydrogen sulfide. Results of collection efficiency were well over 90%. The analytical method is sensitive and requires little time in procedure. - Authors' Abst.

928. Stratmann, H.: Microanalytical methods for determining sulfur dioxide in the atmosphere. Mikrochimica Acta pp. 668-678, 1954.

This paper describes a method whereby the gas is absorbed first on silica gel and then reduced to hydrogen sulfide by a platinum contact at 700-900°C. This, together with excess hydrogen, is passed into a 2% solution of ammonium molybdate in 0.4N sulfuric acid. A blue-violet molybdenum complex is formed which can be evaluated with the aid of the 857 filter. Good quantitative results can be obtained with 1-200 micrograms of hydrogen sulfide, by suitably varying the quantity of the reagent. If air contains more than 300 mg of water, the air should be dried by conducting it through phosphorine anhydride. As little as 0.01 microgram of hydrogen sulfide per liter of air can be determined without difficulty.

929. Sullivan, J.L.: Particulate and gaseous pollution in New South Wales cities. Clean Air Conference, Sydney, Feb. 19-21, 1962.

This paper deals with comparisons of smoke concentrations between New South Wales and American and British cities. The sulfur dioxide concentrations are similar to concentrations in American cities and are about one tenth of British levels. Low level inversions characteristic of the area concentrates pollution from domestic and other low level sources, the industrial pollution (mainly sulfur dioxide) is discharged sufficiently high and hot to penetrate the inversions.

930. Taga, T.: The flue SO_2 and SO_3 sampler with some considerations of its application. Heat Management 12:1-12 (Sept.) 1963.

A flue gas sampler, manufactured by the Kanto-Shinetsu Heat Control Soc., has been used in a series of experimental studies of nearly 120 samplings at some 40 industrial plants in the period from April 1962 to March 1963. The details of the structure of the sampler are discussed. A diagrammatical sketch of the sampler is given in the text. Also discussed is the method of measurement and the calculations of SO_2 and SO_3 concentrations. Samples were taken at 2 locations, either 0.2 or 1.2 m. in front of the damper. The concentrations of SO_2 and SO_3 varied also with temperature, being at a level of 80 and 957 ppm. respectively, when the furnace temperature was 1240°C., and 5.3 and 46.0 ppm. when the temperature was 1530°C. The relation between the conversion rate of SO_2 and SO_3 and the concentration of O_2 was studied and compared to Macfarlane's formula (J. Inst. Fuel, Nov. 1962), $SO_3/SO_2 = K \times O_2^{\frac{1}{2}}$ where K is the equilibrium constant and is smaller for higher temperatures. The agreement was good. - APCA

931. Terraglio, F.P., and Manganelli, R.M.: Laboratory evaluation of sulfur dioxide methods and the influence of ozone-oxides of nitrogen mixtures. Anal. Chem. 34:675-677 (May) 1962.

A laboratory evaluation of three wet-chemical methods used to measure atmospheric sulfur dioxide concentrations showed that the acidimetric and spectrophotometric methods gave comparable average recoveries over the concentration range of 0.3 to 3.78 mg. of SO_2 per cubic meter. Recoveries by the iodimetric method over the same concentration range were lower than the spectrophotometric method. The presence of ozone-oxides of nitrogen mixtures interfered with all three methods. - Authors' Abst.

932. Thomas, F.W., and Davidson, C,M.: Monitoring sulfur dioxide with lead peroxide cylinders. J. APCA 11:24-27 (Jan.) 1961.

A "field experience in the use of lead peroxide cylinders for evaluating sulfur dioxide reactivity in the vicinity of large coal burning steam plants has been described." An adaptation of a method for construction, preparation and handling the peroxide candles is explained which may offer some practical advantage where transport, shipping or storage is necessary. "At first, a network of about 40 cylinders was operated within radius of six miles of a steam plant for an 8 month period." The effectiveness of the network was impaired by inadequate consideration of meteorological, environmental, and cultural factors in site selection." A second network of six autometers in operation at vicinity of another steam plant was moved to this area where 36 cylinders were exposed for periods of approximately one month each over a period of 13 months. Another network employing a four-month cycle has been operated for about 4 years. The author discusses the relation of sulfation and SO_2 exposure. It was found that correlation was best at the site nearest the source where time for conversion of SO_2 to higher sulfur oxide is minimum. "In an area of moderate or average concentration, a high degree of correlation was noted between SO_2 exposed and lead peroxide sulfation. No deterioration in the rate of reactivity of lead peroxide with SO_2 was noted in periods as long as four months." - PHEA

933. Thomas, M.D., Ivie, J.O., Abersold, J.N., and Hendricks, R.H.: Automatic apparatus for determination of small concentrations of sulfur dioxide in air. Indust. Eng. Chem. 15:287-290, 1943.

The automatic apparatus for the determination of small concentrations of sulfur dioxide in air has been modified by the substitution of a simple multiple-port stopcock-type valve for the numerous poppet valves of the older assembly. This equipment has also been modified to enable the simultaneous determination of the total volatile sulfur compounds in the air, with the same precision and sensitivity as characterized the sulfur dioxide analysis. Carbon disulfide, hydrogen sulfide, ethyl mercaptan, thiophenol, and thiophene have been so determined. The method is also applicable (at a higher operating temperature) to organic chlorine compounds, such as chloroform, carbon tetrachloride, ethylene chloride, and chlorobenzene. Nitrogen compounds could not be oxidized to nitric acid in this equipment. Some observations are given on the physiological limits of detection of sulfur dioxide, hydrogen sulfide, and ethyl mercaptan. - Authors' Abst.

934. Thompson, C.J., Coleman, H.J., Ward, C.C., and Rall, H.T.: Desulfurization as a method of identifying sulfur compounds. Anal. Chem. 32:424-430, 1960.

The desulfurization technique described is rapid and economical, and has produced complete desulfurization of all molecules tested to date. Extremely small samples can be handled; the lower limits have not been established, but they are well under 0.0002 ml. The sulfur compound from which the hydrocarbon is produced will be ambiguous in some instances, but the identity of the hydrocarbon, coupled with other information such as previous sample treatment, GLC retention, time, and spectral data, should result in many identifications of sulfur compounds in crude oils for which reference compounds are not available. This technique may be useful also in nitrogen and oxygen studies, where preliminary data show that some of these compounds react in a manner analogous to sulfur compounds. The procedure also should be helpful in the production of small amounts of reference hydrocarbons needed in GLC work for which samples are not available. A typical example of such aid would be the production of cyclohexyl derivatives from available aromatics. - Authors' Concl.

935. Torres, O.: Determination of sulfur dioxide in contaminated air. Modifications of the iodimetric methods of Marston and Wells, of Thomas, and of Ellis. Rev. Soc. Quim. Mex. 4(6):201-206, 1960.

The construction and use of a specially designed apparatus, equipped throughout with ground-glass joints, for the iodimetric determination of SO_2 in air are described. The apparatus provides for measurement of the vol. of air passed by means of a flow-meter and a chronometer and for additions by micro-burette of 0.005N-iodine to the absorbing KI per liter, without interrupting the air flow. Lower concn. of iodine (down to 0.00013N) are used in the absorbing soln. than in the method of Thomas and Cross, thus eliminating loss of iodine by volatilization. - PHEA

936. Troy, D.J.: Measurement of atmospheric pollution by ultraviolet photometry. Anal. Chem. 27:1217-1221, 1955.

A sensitive portable ultraviolet photometric analyzer is an extremely convenient device for determining the concentration of toxic gases and vapors in the atmosphere, but instruments described in the literature have generally been limited to one analytical wave length, 254 mu, and data on the absorptivity of gases and vapors, on which analyzer calibrations could be based, have been scanty. A portable ultraviolet gas and vapor analyzer, based on Hanson's design, has been gradually improved during several years' experience with a number of these instruments at several chemical manufacturing plants. The wave-length range of the analyzer has been extended by relatively simple techniques, thereby enhancing sensitivity and minimizing interference. A convenient gas-mixing apparatus for calibrating sensitive gas analyzers under simulated operating conditions at concentrations from 20% to 0.1 ppm. has been developed. The extended wave-length range and the use of the calibrating apparatus have materially increased the utility and precision of the portable ultraviolet analyzer in the analysis of toxic gases and vapors in the atmosphere. - Author's Abst.

937. Urone, P.F., and Boggs, W.E.: Acid-bleached fuchsin in determination of sulfur dioxide in the atmosphere. Anal. Chem. 23:1517-1519 (Oct.) 1951.

Steigmann's colorimetric method for determining sulfur dioxide in air in the presence of sulfur trioxide, hydrogen sulfide, and other impurities is being discussed. This method is simple and reliable and allows the preservation of field samples for later analysis in the laboratory. The color reagent consists of a mixture of basic fuchsin, sulfuric acid and formaldehyde which develops a red-violet color in the presence of sulfurous acid. The intensity of the color produced is proportional to the concentration of the sulfur dioxide and may be measured accurately by means of a spectrophotometer or colorimeter.

938. Vajna, S.: Removal of hydrogen sulfide from industrial gases by a purifying mass containing iron hydroxide, I. Acta Chim. Acad. Sc. Hung. 2:163-174, 1952.

The reaction of gas purifying mass containing iron hydroxide with hydrogen sulfide in gases can be presented by a simple formula, assuming that the slowest phase of this complex process consisting of several phases is the passing of the hydrogen sulfide through the surface of contacts of the mass. Assuming that a stationary state is attained in an endless column, a formula has been evolved for indicating the changes in the hydrogen sulfide contents of the gases. Moreover, it was affirmed that iron hydroxide columns of 40 cm thickness, as generally used in plant practice, can be considered as endless columns in respect to the hydrogen sulfide content occurring in the practice. The experimental results show slight deviations from the theoretically calculated values and these only in the region close to the full saturation of mass. The evolved formula is suitable for the determination of the quantity of gas which can be purified, the latter being a function of the sulfur absorbing capacity of the mass, the sulfur content and the flow rate of the gas.

The experiments were performed with a synthetic mass which contained only gypsum besides iron hydroxide. - Author's Abst.

939. Varlamov, M.L., Krichevskaya, E.L., Manakin, G.A., Moxakova, L.M., and Gospolinov, A.N.: Acoustic coagulation of sulfuric acid mist. J. Appl. Chem. (USSR) 33:11-17 (Jan.) 1960.

The acoustic coagulation of sulfuric acid mist in a sound field was studied. The sound field was produced by a GS-2 gas jet generator. It was established, over the range studied, that the optimal frequencies were 16 and 22 kc. An increase in sound intensity improved coagulation with the effect of intensity stronger at low frequencies. The degree of coagulation depended on the initial mist concentration and decreased both at low and very high frequencies. A degree of purification above 97% was achieved at an average sound intensity of 0.2-0.25 w./cm.^{2} and an initial mist concentration of 1.7-8.7 g. H_2SO_4/nm.^{3} - APCA

940. Vint, W.D.: Modern methods of gas analysis. VIII. Detection and estimation of impurities in industrial gases. Metallurgia 37:317-318 (April) 1948.

Gas analysis apparatus described in previous sections have certain limitations in estimating such impurities as NH_3, H_2S, SO_2, etc., and there are many instances where their determination is necessary. A choice of several methods usually exists for each of the following impurities and in such cases only the simplest and most reliable methods are mentioned: hydrogen sulfide, total sulfur estimation, detection and estimation of the more uncommon gases, and determination of moisture in gases. - Author's Sum.

941. Wahnschaffe, E.: Sulfur removal from flue gases by the Reinluft process. Mitt. V.G.B. (April) 1963.

This paper describes the operating experiences of the Volkswagen Werk Wolfsburg with a pilot plant employing the Reinluft process. The experiences of 1959 are reported and the results are discussed. The plant designed to clean 1,000-2,000 Nm^3/hr of flue gas, removed approximately 2,000°C from the air preheater of an oil-fired boiler. Corrosion damage and stoppages were noted. Plans have been made for a plant to handle 60,000 Nm^3/hr of flue gas with 80% efficiency.

942. Wallis, E.: The recovery of sulfur in a marketable form from flue gases. British Chem. Eng. 7:833-836 (Nov.) 1962.

This paper describes operating experiences of a plant which recovers the sulfur in gases as elemental sulfur and ammonium sulfates. The Fulham-Simon-Carves process and its future application is discussed.

There is also a brief review of earlier attempts to recover sulfur from flue gases of thermal power stations.

943. Welch, A.F., and Terry, J.P.: Developments in the measurement of atmospheric sulfur dioxide. Am. Indust. A. J. 21:316-321 (Aug.) 1960.

In the course of an air pollution research study in Nashville, Tennessee, the sodium tetrachloromercurate (TCM) method for collection and analysis of low concentrations of sulfur dioxide was found to be accurate, highly sensitive, flexible, and practical. The adaptation of this method to use with an automatic analytical instrument and methods of rapid midget bubble handling, washing, and filling procedures are described. The relationship between this modified TCM method and 2 other methods was investigated, using synthetic mixtures of sulfur dioxide in air. A dynamic calibration procedure showed that Thomas Autometer and the TCM results are identical. The relationship between the hydrogen peroxide and TCM methods was found to be: (hydrogen peroxide results in ppm) = 0.72 x (TCM results ppm) + 0.04. The lead peroxide candle method for estimation of sulfur dioxide as used in Nashville is described. - Authors' Sum.

944. Wells, A.E.: The Wet Thiogen Process for Recovering Sulfur from Sulfur Dioxide in Smelter Gases. USDI, BMB 133, 1917.

This is a critical study of the wet Thiogen process for extracting sulfur from the smoke of smelters. The results of the investigations herein described warrant the statement that every step of the wet Thiogen process can be controlled and carried out successfully on a small laboratory scale, and the indications are that the same success can be expected in the large-scale operations of a commercial unit. There are no factors to prevent the successful conduct of the following operations: Absorption of the sulfur dioxide gas by the mother liquor solutions, precipitation of the sulfur compounds by the addition of barium sulfide to the solutions, settling of the precipitate, decantation of the solution, dewatering or filtering of the precipitate, and distillation of sulfur from the dried precipitate.

945. West, P.W., and Gaeke, G.C.: Fixation of sulfur dioxide as disulfitomercurate (II) and subsequent colorimetric estimation. Anal. Chem. 28:1816-1819 (Dec.) 1956.

Sulfur dioxide in the atmosphere is removed and concentrated by scrubbing through 0.1M sodium tetrachloromercurate (II). Stable, nonvolatile disulfitomercurate (II) is formed. The subsequent determination of the isolated sulfur dioxide is based on the red-violet color produced when p-rosaniline hydrochloride-hydrochloric acid mixture (0.04% dye-6% concentrated acid) and formaldehyde (0.2%) are added to the sampling solution. The absorption maximum is at 560 m and the color is temperature-independent and stable for several hours. The method is sensitive (0.005 to 0.2 ppm with a 38.2-liter air sample scrubbed through 10.0 ml. of sampling solution) and should be useful in the absolute determination of sulfur dioxide in air pollution surveys. Nitrogen dioxide is the only common interference. - PHEA

946. West, P.W., and Ordoveza, F.E.: Elimination of nitrogen dioxide interference in the determination of sulfur dioxide. Anal. Chem. 34:1324-1325 (Sept.) 1962.

In the spectrophotometric estimation of SO_2 with hydrochloric acid-bleached pararosaniline hydrochloride and formaldehyde, interference due to oxides of nitrogen has been eliminated without complication of the original procedure of West and Gaeke. Addition of 0.06% sulfamic acid to 0.1M sodium tetrachloromercurate (II) used as absorbing solution for SO_2 from the atmosphere immediately destroys any nitrogen dioxide present. - Authors' Abst.

947. Whittingham, G.: The corrosive nature of combustion gases from carbon monoxide flames containing sulfur oxides. J. Applied Chem. (London) 5:316-322 (July) 1955.

Mild steel corrosion probes have been used to determine the relation between surface temperature and amount of iron corroded by the flue gases of relatively low moisture content from a diffusion flame of carbon monoxide, to which additions of sulfur dioxide were made. Complementary measurements have been made of the percentage conversion of sulfur dioxide to sulfur trioxide and of the rates of acid build-up on a dewpoint meter. Over the temperature range employed, corrosion showed a maximum at 66° to 70°, and humidity of combustion air was found to have a significant effect on corrosion. From the dewpoint meter readings and other data, theoretical rates of acid deposition of the corrosion probe have been calculated and these and the experimental values are compared and discussed. - APCA

948. Wyszynska, H., and Kosinski, K.: Sulfur dioxide determination by means of contact method in the air of Warsaw. Roczniki Zakladu Hyg. (Warsaw) 13:377-383, 1962.

The method for SO_2 determinations in atmospheric air, based upon the absorption of the gas in cloth saturated with lead dioxide is presented. The method is simple with no special apparatus being necessary, thus making it applicable for use in sanitary-epidemiological stations. On the basis of the results from the examinations over a period of a yr. (1961-62) from 9 collection points in Warsaw, it was stated that the SO_2 content varied from 0.08 to 2.60 mg./100 cm.^{2} PbO_2/day, which corresponds to 0.01 to 0.23 mg. SO_2/m.^{3} of air. During the periods of house-heating, the values were 5-fold higher than during the summer season. - APCA

949. Yocum, J.E., Richardson, R.L., Saslaw, I.M., and Chapman, S.: The effect of hydrogen chloride on the operation of the Thomas Autometer. Proc. 49th Meeting APCA, May 20-24, 1956, Paper No. 4, 10 pp.

The Thomas Autometer is one of the most widely used instruments for detecting minute concentrations of sulfur dioxide in gas. The operation of this instrument is affected by the presence of hydrogen chloride, since its conductivity is added to that of sulfuric acid formed in the reaction.

This paper reports the results of a series of experiments which were performed to determine the absorption efficiency and average over-all mass-transfer coefficient for hydrogen chloride-autometer system using H_2SO_4-H_2O_2 absorbing solution.

950. Younglut, K.C.: How first electrostatic desulfurizer has performed for Cities Service. Oil & Gas J. 57:78-80, 1959.

The first commercial electrostatic desulfurizer went into operation at the East Chicago, Ind., refinery of Cities Service Oil Co. in October 1958.

This installation represents the initial attempt to desulfurize catalytic reformer feed stock with sulfuric acid. Another unusual feature is that spent alkylation acid is used as the primary treating agent.

Operating experience may be summarized by these results: Efficiency of sulfur removal has been in the range of 80 to 90%. The plant has had no difficulty meeting performance guarantees.

Significant reduction in the amount of trace contaminants such as metals has also been realized.

The process appears to be economically competitive with other methods of desulfurization.

The ultimate effect upon platinum catalyst of acid-treating reformer feed stock has not been fully evaluated. The initial run of the reformer was terminated prematurely due to excessive coke in the feed-recycle gas heat exchangers and on the platinum catalyst. The source of the coke-forming materials has not been determined.

951. Zieren, A.: Washing and cooling of gases containing sulfur dioxide. Atmospheric Poll. Bull. 23:57 (Feb.) 1956.

Claim 1: A process for washing and cooling roasting and combustion gases containing sulfur dioxide in two or more successive towers to obtain a purified sulfur dioxide by spraying with diluted sulfuric acid continuously circulated in a separate closed circuit for each tower, wherein the acid is fed to the first tower at about the temperature to which the gases are to be cooled in that tower, the acid being maintained at a concentration such that the desired cooling occurs due to evaporation of water therefrom without substantial rise in temperature of the acid, that is by utilizing the sensible heat of the gases to supply the latent heat is reconverted to sensible heat on condensation in the second tower and which sensible heat is removed from the wash liquid in the second tower by passing the wash liquid, during circulation thereof, in contact with cooling surfaces. - PHEA

952. Zimmermann, H.: Determination of traces of sulfur in small amounts of air. Angew. Chem. 71:336-338, 1959.

The sensitivity of Wickbold's method for the turbidimetric micro-determination of SO_4^{2-} has been increased 200-fold so that 1.0 g of S can now be accurately determined. The volume of the test soln. was reduced by using a cell with 20-mm transmission, but only 3 mm wide; with a 10-mm cell, 0.5 g can be determined less accurately. A very sensitive Eppendorf photometer was used. During the addition of the titrant (0.0191% aq. $BaCl_2$ soln.), the soln. should be stirred mechanically. The electrolyte is a soln. of $MgCl_2$ (20 g) and NH_4Cl (2.5 g) in H_2O (1 liter), adjusted to pH 8.0 to 8.2 with aq. NH_3. To decrease the volatility of SO_4^{2-} when evaporating a soln., add a 1% aq. soln. of NaCl. The sensitivity can be increased by adding an aq. soln. of K_2SO_4 (0.543 g, or less, per liter) and deducting the amount of S thus added from the value obtained. The apparatus for sampling the air and oxidizing the sulfur compounds is described. The accuracy is a few percent in the determination of 0.5 g of S; by adding SO_4^{2-}, 0.1 g of S (i.e. 0.2 ppm of S in a few liters of air) can be determined with lower accuracy. - PHEA

953. Zvinca-Selegean, R., Cariadi, L., and Racoveanu, N.: Polarographic determination of sulfur dioxide in the atmosphere. Rev. Chim. Bucharest 9:39-44, 1958.

From a comparison of various methods, it is claimed that the most sensitive is the colorimetric one with a lower limit of 0.1 ug, followed by the nephelometric (2 ug), polarographic and conductimetric (10 ug), and the iodimetric (14 ug). The upper limits are 10 ug for colorimetric, 15 to 20 ug for nephelometric, judged visually, or 50 to 60 ug with Pulfrich turbidmeter. For determinations between 1 and 15 ug, results from the colorimetric, nephelometric and polarographic methods are in good agreement. Only the nephelometric and polarographic methods can be considered satisfactory for specificity. Procedure - The sample is aspirated into 10 ml of 0.1 N NaOH, and amounts from 0.1 to 2 ml are pipetted into the cell, and diluted to 5 ml with HCl (0.1.N) plus 2 drops of methyl red. The polarograms have E ½ for SO_2 lying between - 0.2 and 0.4 V, and must be obtained at exactly the same temp. as that used for the standard curves. Concn. of up to 0.1 mg of Cl, 0.003 g of NH_3 and 0.02 mg of H_2S per liter do not appreciably affect the results. - PHEA

954. Air Pollution Manual Part I Evaluation. Am. Indust. Hyg. A. 1960.

This volume includes the following sections: Legislative and Administrative Procedures. Community Relations. The Concentrations of Atmospheric Particulate Matter in Selected Urban and Non-urban Locations. Effect of Air Pollution on Health. Effect of Air Pollution on Vegetation. Effect of Air Pollution on Farm Animals. Economic Effects of Air Pollution. Community Air Sampling. Stack Sampling. Chemical Procedures. Odors. Radioactivity; Meteorology, and has been designed to assist in making available the kind of information needed for the intelligent appraisal of air pollution problems. It was prepared by a group of engineers, chemists, toxicologists, physicists, meteorologists and other specialists whose common fields of concern are industrial hygiene and air pollution. The book is intended to be practical and each section is so written that the reader will better understand the actual problems he may encounter. If called upon to sample a stack, for example, the reader will find a discussion of air flow measurement, sampling devices and methods, and ample literature references to proven sources of information, so that with adequate scientific training he can approach a problem in a practical and efficient manner.

955. Air Pollution Measurements of the National Air Sampling Network. Analyses of Suspended Particulates, 1957-1961. PHSP 978. USDHEW, PHS, Div. of Air Pollution, Washington 25, D.C., 1962. 217 pp.

On January 1, 1957, major revision of the network operations was initiated. With these revisions the network became truly "national." There are currently 250 sampling stations in the network, 213 urban and 37 non-urban. Of the urban stations, 73 sample every year and 140 sample every other year. Thus, in any 1 year there are 180 stations actively collecting samples, 143 urban and 37 non-urban. Every year urban sampling stations are usually located in the largest city, by population, of the 50 states, the District of Columbia, and Puerto Rico. In addition there are frequently several every-other-year stations in operation, some of which have been operated during the off year by the respective State agencies. Particulate matter collected by the National Air Sampling Network is made up of the small particles which remain in suspension in the air for varying periods of time. The national urban mean concentration of suspended particulates for 1957-61 was 104 ug./m^3 with a max. concentration of 1706 ug./m^3. The frequency distribution of mean concentrations, which for 190 cities ranged from 46 to 224 ug./m^3 is shown graphically in a figure in the text. This information is contained in Part I of the publication. Other parts of the publication are concerned with Data tables: Sampling site description and participating organization: Analytic methods; Explanation of statistical terms. - APCA

956. Altshuller, A.P.: Air Pollution. Anal. Chem. 35:3R-10R (April) 1963.

This literature review covers the period from January 1961 through October 1962. It supplements the previous review (Lodge, J.P., Jr.: Anal. Chem. 33:3R, 1961), except that the section on meteorology and the discussion of the measurement of dusts have been omitted.

The observations made in the last review on the continued interest in automobile exhaust and carcinogens are still relevant. Increased work also is being done on the analysis of photochemically reactive atmospheres in the United States. Investigations of Diesel exhaust composition are beginning to assume importance. Most of these problem areas have stimulated analytical work in the United States, particularly on organic analysis.

Symposias and Conferences held, as well as reports and monographs published during the above mentioned period are discussed.

Articles are reviewed in following sections: Biological Indicators; Particulates and Aerosols; Inorganic Gases; Organic Gases and Vapors; Atmospheric Reactions; Analysis of Sources of Pollution; Field Studies. Two hundred and forty references are cited.

957. ASTM Standards on Methods of Atmospheric Sampling and Analysis. ASTM Committee D-22. American Society for Testing Materials. Philadelphia, Pa., 1959. 104 pp.

Definitions of terms relating to: Atmospheric sampling and analysis. Recommended practices for: Planning the sampling of the atmosphere. Sampling atmospheres for analysis of gases and vapors. Methods of testing for: Inorganic fluoride in the atmosphere. Nitrogen dioxide and nitric oxide content of the atmosphere. Odor in atmosphere. Odor in industrial water and industrial waste water. Odorous vapors. Oxides of nitrogen in gaseous combustion products. Oxidant content of the atmosphere. Particulate matter in the atmosphere. Sulfur dioxide content of the atmosphere, continuous analysis and automatic recording. - APCA

958. Conference Report Third Air Pollution Research Seminar, New Orleans, La., March 22-24, 1960. USDHEW, PHS, Div. of Air Pollution, Washington, D.C.

This report contains summaries of the 81 papers presented at the Third Air Pollution Seminar. They are grouped in following order: International Aspects. Sampling and Identification. Meteorology. Pulmonary Physiology. Effects of Air Pollution. Engineering. Environmental Levels of Pollutants. Toxicology. Automotive Exhaust Research. Pathology. Chemistry. Community Studies.

959. Domingues, L.P.: Sulfur in bone char. In: Deitz, V.R. (editor): Proc. Third Technical Session on Bone Char, 1953. Bone Char Research Project, Inc., Charlestown, Mass., pp. 307-312.

Char revivified in the presence of sulfur dioxide increases appreciably in total sulfur. The extent depends upon the initial concentration of sulfur dioxide, the time, and the temperature. The increase in the sulfur content is in the inorganic-sulfur, the reducible-sulfur, and that combined with the carbonaceous residue. Some experimental results are given for a char before and after regeneration in the presence of sulfur dioxide. The sulfate content imparted to char liquors can increase greatly without forming a "sulfate base". Analyses of test liquors for calcium and sulfate are given before and after passing through a service char, through a mechanical mixture of char and calcium sulfate, and through a char regenerated in the presence of sulfur dioxide. - Author's Abst.

960. Faith, W.L., Hitchcock, L.B., Neiburger, M., Renzetti, N.A., and Rogers, L.H.: The Second Technical Progress Report - No. 12. Air Pollution Foundation, 704 So. Spring St., Los Angeles 14, California. 1956, 143 pp.

This report deals primarily with studies of the Los Angeles atmosphere. It presents a summary of technical knowledge in the field of air pollution at the present time; representing the fields of chemistry, chemical engineering, physics, and meteorology.- APCA

961. Faith, W.L., Renzetti, N.A., and Rogers, L.H.: Fifth Technical Progress Report. Air Pollution Foundation, San Marino, California, Report No. 27, 1959, 77 pp.

I. Irradiation of automobile exhaust. II. Photochemical reactions. III. Exhaust control methods. IV. Sulfur dioxide. Appendix. Irradiation of automobile exhaust has shown that car variables influenced eye irritation as much as fuel variables. When the exhaust ratio and the automobile were adjusted to give hydrocarbon and nitric oxide concentrations in the approx. range of 2-5 ppm. and 0.5-2 ppm. respectively, and their ratio of concentrations was in the range of 2-8, significant eye irritation was produced with all fuels, but exhaust from the 52% olefinic fuel gave greater eye irritation. Good correlations were found between eye irritation and the concentrations of certain C_4 and C_5 olefins in the exhaust; other hydrocarbons did not show such correlations. Ozone concentration produced by irradiation of exhaust was independent of fuel composition; aerosol was dependent on both the olefin content and the sulfur content of the fuel. Several olefinic hydrocarbons were added to the exhaust-air mixture in the smog chamber. Eye irritation was usually increased. Two exhaust control devices that eliminated hydrocarbons were tested. Both eliminated eye irritation. - APCA

962. Faith, W.L., and Renzetti, N.A.: Sixth Technical Progress Report. Air Pollution Foundation, San Marino, California, Report No. 30, 1960, 81 pp.

Photo-oxidation of hydrocarbons. Treatment of motor vehicle exhaust gases. Research in atmospheric chemistry. Air quality and motor vehicle exhaust emissions. This report reviews the work sponsored by Air Pollution Foundation during 1959, as well as other pertinent studies. With the recent development of improved tools and techniques, it has become possible to identify some of the products of the photo-oxidations and to delve into the nature of the eye irritants, the oxidant, the aerosol particles, and the plant damaging agents. A gas chromatographic analyzer and an infrared spectrophotometer were used to measure concentrations of reactants and products. Aerosol studies relative to the photo-oxidation of sulfur dioxide were carried out. During the present study several olefinic and saturated hydrocarbons were investigated. - APCA

963. Isaac, P.C.G.: The Effects, Measurement, and Control of the Atmospheric Pollution Due to Combustion. A Review and a Bibliography. University of Durham, King's College, Dept. of Civil Engineering, Bull. No. 3, 1954, 32 pp.

Of the 3 types of air pollutants - gaseous effluents from atomic energy plants, toxic gases or dusts produced by industrial processes and products of combustion, the last is considered the most important. A table shows the amounts of atmospheric pollution dissolved in the urban area and of suspended atmospheric pollution in the same area, both smoke and SO_2, for 1949-53 in various cities. The studies of the effects of air pollution on health in the 1952 fog, the studies of Amdur, et al. and some cancer studies, are briefly reviewed. The other effects of smoke, the cost of smoke, measurement of air pollution, variations in atmospheric pollution, meteorology and atmospheric pollution, efficient combustion and flue-gas cleaning are also briefly reviewed. An extensive bibliography of 176 references is given. - KB

964. Jacobson, I.A., Jr.: Thermal decomposition of organic nitrogen and sulfur compounds: A survey of chemical abstracts 1930 to 1956. USBMC 7947, 1960, 99 pp.

This report is divided into three parts. Part I lists nitrogen compounds; Part II, sulfu compounds; and Part III, compounds containing both nitrogen and sulfur. The organization of the classes of compounds is alphabetical: Part I - amides, amines, amino acids, ammonia, azides, azines, azo compounds, heterocyclic nitrogen compounds, hydrazine, nitrates, nitriles, nitrites, nitro compounds and miscellaneous nitrogen compounds; Part II disulfides, sulfides (including double and triple sulfides), thiols, thiophenes and xanthates; Part III - thioacid amides, thiazoles, thiocyanates and thiuram disulfides. A class formula is included with each class name. The R's used in these class formulas may refer to hydrogen or to the same or different radicals when more than one R appears.

The scheme used for presenting the data is as follows: I. Class name. A. Type of compound (aliphatic or aromatic). 1. Specific compound name. a. Reference. Data concerning the reaction.

965. Juda, J., and Budzinski, K.: Atmospheric Pollution. March 31, 1963, 261 pp. Translation from Polish. U.S. Department of Commerce, Office of Technical Services, Washington, D.C., Translation No. 63-21460.

The information is assembled in 3 parts. Under General Information, in Pt. I, the chapter titles are: Systematic Classification of Atmospheric Pollutants; Sources of Atmospheric Pollutants; and Damage Caused by Atmospheric Pollution. In Pt. II, on Dispersion of Pollutants in the Atmosphere, the headings are: Aerosol Mechanics; The Influence of Meteorological Conditions on the Dispersion of Pollutants; and Dispersion of Pollutants in the Atmosphere. In Pt. III, on Testing of Atmospheric Pollutants, the headings are: Methods of Measuring Atmospheric Pollution; Determination of Pollutant Emission; Estimation of Dustfall; Determination of Particulate Matter Concentration in Air; and Determination of Gaseous Air Pollutants. There is a bibliography at the end of each chapter and also a short general bibliography at the close of the book. - APCA

966. Kaliuzhnyi, D.N.: Protection of Atmospheric Air Against Contamination by Ferrous Metallurgical Discharges. Kiev, Gosmedizat. U.S.S.R. 1961. 180 pp.

The information of this book, on the protection of atmospheric air against contamination by ferrous metallurgical discharges, is discussed by chapters under the following headings: The present day state of sanitary protection of atmospheric air in the U.S.S.R. and some foreign countries; Sources of ferrous metallurgical discharges of atmospheric air pollutants (such as fuel combustion, processing of raw materials, production of coke, and types of open hearth and blast furnaces); Related sources of pollutants; Effects of ferrous metallurgical discharges on the sanitary conditions of atmospheric air of polluted areas; Relationship between types and intensities of atmospheric air pollution and certain types of diseases, based on the data found in the literature and from clinical and dispensary records, as well as from the results of general population surveys; Effects of such discharges on the sanitary, hygienic, and general living conditions and on vegetation; Basic means for the protection of atmospheric air in populated areas and in regions surrounding ferrous metallurgical industries. The 1st supplement, at the end of the book, deals entirely with a proposed program of study for purposes of establishing control of such installations. The 2nd supplement outlines a sanitary classification of industries in relation to sanitary protection zones (greenery). Heights of smoke stacks in relation to vol. of discharge are discussed in supplement 3. The other supplements consist of tables on the following subjects: Width of sanitary protection zones surrounding electric heat and power stations (based on vols. of fuel consumed); Limits of allowable concentrations of specific substances in the atmospheric air of populated areas; Tons of residual discharge fly ash (in 24 hrs.) after passing ash removers; Densities of particulates suspended in industrial gases; Efficiencies of different types of U.S.S.R. ash-catching installations. Much of this supplementary information can be found translated in vol. 6, 117-135, of B.S. Levine's U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. - APCA

967. Katz, M.: The Greater Detroit-Windsor air pollution study. Part II -- Investigation of environmental contaminants by continuous observations and area sampling. Am. Indust. Hyg. Quart. 13:211-225, 1952 (Also appeared as: Sources of pollution). Proc. 2nd National Air Pollution Symposium, Pasadena, Calif. (May 5-6) 1952, pp. 95-105.

The Detroit River area is the 3rd largest manufacturing region in North America with over 5,000 major industrial establishments of many types. About 28,000 vessels are estimated to go up or down the Detroit River in the navigation season and consume ca. 16 million tons coal/yr. Besides this, the total domestic and industrial consumption of coal and solid fuels is ca. 15 million tons/yr. on the U.S. side and ca. 650,000 tons on the Canadian side. Assuming S content of the fuel to be 1.5% and that 90% of this S is released to the atmosphere, approximately 430,000 tons SO_2 are emitted from solid fuels alone, not counting other fuels and industrial processes. Also many other process wastes consisting of gases and aerosols contaminate the atmosphere. Data on smoke emission from river vessels were collected and reported by Canadian investigators, and a marked improvement in smoke performance has been noted. A summary of meteorological data, i.e., direction and hourly speed of wind and number of cloudy days, in the Detroit-Windsor area by month for 1945-49 is given. In general, lower winds and less cloudy days occur in the summer months. The prevailing wind is SW, except in Jan. and Feb. when it is W. The monthly mean and maximum concentrations of SO_2 (ppm) at 4 stations in Windsor area from Sept. 1950 - Dec. 1951 are tabulated. The months during which the pollution level is highest, viz., April, May, Nov. and Dec., coincide with the period of the year showing the greatest number of cloudy days and highest incidence of temperature inversions. At the station near the Windsor-Detroit Tunnel entrance (greatest pollution), the mean concentration varied from 0.047 (June '51) - 0.149 (Dec. '51), with the maximum concentrations ranging 0.207 (March '51) - 0.557 (Dec. '50). At the station 15 mi. S of Detroit River (least pollution), mean concentrations ranged 0.0008 (April '51) - 0.0266 (Dec. '50), while maximum concentrations ranged 0.031 (March '51) - 0.307 (Nov. '50). Higher peak concentrations of very short duration were recorded in Nov. (1.105) and Dec. (1.210) '51 and Jan. '52 (2.706 ppm for 4 min.). Such concentrations are greater than those recorded in Los Angeles and Yonkers, N.Y., etc. However, no major smog disaster has occurred as yet because of the topography of the area. Intermittent samples of H_2S, Cl_2, N oxides and NH_3 were collected and the mean and maximum concentrations of these by location are given. High concentrations of suspended PM usually coincide with periods of smog and relatively heavy SO_2 concentration. Daily average concentrations for the area from Oct. 24 - Dec. 5, '51 ranged 0.067 - 0.260 mg./m.^{3}. The mean, minimum and maximum concentrations (mg./m.^{3}) at 26 stations in the Windsor area are tabulated. The most heavily polluted areas on the Canadian side lie close to the Detroit River and in zones of major industrial operations; moderate to low pollution occurred in the E and S of Windsor, and the lowest in Tecumseh and McGregor, Ontario. The distribution of deposited matter, including total solids, insoluble/H_2O and soluble/H_2O solids, tar, other combustible matter, ash, S as SO_4, Cl, lime and pH, at 20 stations for the period approximately from Aug. - Dec. '51 is tabulated. A mean of 92 tons/sq.mi./mo. of total solids was recorded in the heavily polluted areas; 53.9 in the heavy to moderate polluted areas; and 42.7 - 35.9 in the moderate-low areas. The average monthly dustfall pollution in the heavily contaminated area of Windsor is apparently greater than that reported for Chicago, Cincinnati, Los Angeles, Toronto and for Pittsburgh in 1950. X-ray diffraction analysis of the suspended PM identified about 20 metals and showed Ca, Si, Al and Fe to be the most abundant, and Pb, Cu, Zn and Mn the next most abundant. All these studies of the environment are being correlated with a view to providing enough information to serve as a basis for surveys of the effects of such conditions on public health, vegetation, safety and economy. - KB

968. Lent,...: Report of the Activity of the Commission on Air Purification of the VDI. In: Fachtagung des Städtetages Nordrhein-Westfalen über Massnahmen zur Reinhaltung der Luft in Städten Jan. 8, 1958, Wuppertal. Städtehyg. 10:59 (March) 1959.

Within the Commission of the VDI, there are about 120 scientists from government bureaus, universities, and industry who are working on the various problems of air pollution and purification. There is the greatest demand for a system of strong regulatory measures. The measurement values of air pollution are only relatively correct but the measuring stations can, however, be considered on a comparative basis. Dustmeasuring devices, in particular, give different values. For gases the measuring devices are excellent. It is possible to register well the amount of H_2S, SO_2, NO_2, HCl, and HF. The SO_2 as the chief problem in this country, is being emitted in increasing quantities so that one must reckon with the possibility that the concentrations may reach dangerous levels. Even the very highest of stacks do not offer too great protection since the thermal layering of the air can prevent a normal diffusion of the gas. About 30% of the total smoke produced in a city comes from domestic sources. Some suggestions of air pollution control are the changing over to gas and electricity of the smaller plants, and the installation of central heating in private dwellings. - APCA

969. Lodge, J.P., Jr. (editor): Atmospheric Chemistry of Chlorine and Sulfur Compounds. Geophysical Monograph No. 3, pub. no. 642, Geophysical Union, Waverly Press, Inc., Baltimore, Md., 1959.

This volume presents a group of papers on cloud physics, atmospheric chemistry, and air pollution which were presented at the Robert A. Taft Sanitary Engineering Center. It also contains an extensive discussion. The meeting was convened by the Committee on Atmospheric Chemistry, Section of Meteorology, American Geophysical Union. It was jointly sponsored by the American Geophysical Union and the U.S. Public Health Service.

970. Maga, J.A., and Hass, G.C.: The development of motor vehicle exhaust emission standards in California. J. APCA 10:393-396 and 414 (Oct.) 1960.

California Legislature passed Assembly Bill No. 1368 and Senate Bill No. 117 requiring the Department of Public Health to develop and publish maximum allowable standards of emission of exhaust contaminants from motor vehicles. It was decided that a single standard would be adopted as based upon achievement of acceptable air quality in the area of the state with most serious air pollution problem, Los Angeles County. The calculation of allowable emissions, in principle, was straightforward involving seven steps. In practice, however, the calculation was complicated by several factors, e.g. uncertainties in measurement of vehicle emissions and other pollutants, quantitative relationships between primary smog-producing pollutants and photochemical smog effects.

The air quality standards adopted by the State Department of Public Health were: "Oxidant Index - 0.15 ppm for one hour (KI method) and Carbon Monoxide - 30 ppm for eight hours or 120 ppm for one hour. Oxidant is used as an indirect measure of the three sensible smog effects; eye irritation, plant damage, and photochemical aerosol formation. While standards were considered for ozone and nitrogen dioxide they were not adopted because of lack of sufficient data.

Relationships between olefins and sensible smog effects were recognized; however field measurement of olefins in exhaust were not practicable. Hydrocarbons were selected as a measureable exhaust component and were expressed in the standards as hexane--275 ppm along with carbon monoxide--1.5% by volume. Methods and rationale for extrapolating require reductions in these exhaust components to the year 1970 and arriving at the present standards are presented. - PHEA

971. Maga, J.A.: Statewide air pollution standards in California. Am. Indust. Hyg. A. J. 21:430-435 (Oct.) 1960.

The State Board of Public Health, California, by act of legislature in early 1959 was required by February 1, 1960 to develop standards for the quality of air for air emissions of exhaust from motor vehicles. Standards were adopted by the State Board of Public Health on December 4, 1959. With these standards, the Governor called a special legislative session in early 1960, resulting in enactment of bill requiring exhaust emission control devices on automobiles. The standards are given.- PHEA

972. Maga, J.A., and Goldsmith, J.R.: Standard for air quality in California. J. APCA 10:453-455, and 467 (Dec.) 1960.

The interest in air quality standards has been an outgrowth of the air pollution problem in California. Although the most serious problem is found in Los Angeles, air pollution levels sufficient to cause eye irritation, vegetation damage, and reduced visibility have been experienced in the larger metropolitan regions of the State. It is hoped that air quality standards adopted by the California State Dept. of Public Health will be of value in the State's attack on air pollution and promote studies and research needed to refine and extend the standards. Standards can only be guides and not a substitute for knowledge and good judgment. As in the case for other standards, those for air quality are not precise figures below which there is complete safety and above which there is certain illness or death. They can sometimes be exceeded without injury to an individual. The air standards that have been adopted will have to be used intelligently with the appreciation of their limitations as well as their application. - APCA

973. Maga, J.A., Hass, G.C., and Wong-Woo, H.: California Standards for Ambient Air Quality and Motor Vehicle Exhaust. Suppl. I. State Dept. of Public Health, Berkeley, Calif., 1961, 13 pp.

Introduction. Standard for crankcase emissions. Definition of terms for motor vehicle emission standards crankcase emissions. Crankcase emissions (data, calculations, and revised inventory). Approach to crankcase emission standard (numerical standard, modes of operation, expression of numerical standard). This is supplement 1 to the technical report of 1960. Others will be published as new standards are added. - APCA

974. Magill, P.L., Holden, F.R., and Ackley, C. (editors): Air Pollution Handbook. McGraw-Hill Book Company, Inc., New York, N.Y., 1956.

This Air Pollution Handbook brings together in readily available form useful information on the major aspects of the problem of air pollution. The Handbook is designed to be used section by section. Each section is independent and treats a single aspect of the broad problem. Generally, Sections 1 and 2 state the situation, Sections 3 through 6 pertain to the science of air pollution, Sections 7 through 9 discuss effects, and Sections 10 through 14 cover various corrective techniques. Each of the contributors was chosen because he could speak authoritatively on one or more phases of the subject.

975. Mallette, F.S.: A new frontier: air pollution control. Proc. Inst. Mech. Engrs. 168:595-628, 1954.

A historical review, particularly of Great Britain and U.S., is presented. The legislation and accomplishments in air pollution control in St. Louis, Alleghany County and Pittsburgh, New York City, California, Los Angeles County and Canada are rather extensively reviewed. Meteorological concepts and factors are discussed. A statistical analysis of concentrations of SO_2 and total particulate matter in relation to meteorological conditions at Donora indicated the shortcomings in the data collected, showed that wind direction and speed, vertical temperature lapse rate and wind shear were the influencing factors on pollution at Donora, and that only about $\frac{1}{2}$ of the variability of the SO_2 contamination could be accounted for by an objective statistical prediction model. A brief account of the Donora smog episode is given and the agents possibly responsible for the deaths are discussed. The development of sampling and measuring instruments for dust, smoke, SO_2 and of meteorological instruments is reviewed. The air pollution problems of the iron and steel industry with respect to each operation are also discussed extensively. Examples of control problems in the steel, power, chemical and rubber industries are given. Finally socioeconomic considerations are discussed rather briefly. There follow discussions of the paper, mainly along engineering lines, by various members of the Institution of Mechanical Engineers from London, Manchester and Glasgow and communications from various other interested persons. The reply by the author is included. - KB

976. Mallette, F.S. (editor): Problems and Control of Air Pollution. Proc. First International Congress on Air Pollution held in New York City, March 1-2, 1955 under the sponsorship of the Committee on Air Pollution Controls of the American Society of Mechanical Engineers. Reinhold Publishing Corporation, New York, 1955.

This collection of papers deals with air pollution problems but attention is focused especially on pollution resulting from burning fuels both in power plants and homes. Nine papers were presented under "Sulfur Dioxide - Treatment and Recovery." The opening paper is by Sir Hugh Beaver who served as chairman of the British Parliamentary Committee on Air Pollution. It was the "Beaver Committee Report" which formulated the British Clean Air Act.

977. McCabe, L.C. (editor): Air Pollution. Proc. United States Technical Conference on Air Pollution. McGraw-Hill Book Co., Inc., New York, New York., 1952, 847 pp.

The purpose of this volume is to bring together in one volume an authentic body of information on the nature and control of air pollution. In the past decade there has grown up in the fields embraced by the physical sciences a considerable store of theoretical and applied information which is increasingly employed in air pollution work. Much of this information grew out of research and development programs sponsored by the civil and military agencies of the Federal Government. In addition to the Government's specialists, it was agreed that outstanding professional men, who were working on various aspects of the problem, should be invited to participate from universities, research foundations, and industry. The conference was divided into the following panels: Agriculture; Analytical Methods and Properties; Equipment; Health; Instrumentation; Legislation; and Meteorology.

978. Meetham, A.R.: The behavior of sulfur dioxide in the atmosphere. In: Lodge, J.P., Jr. (editor) Atmospheric Chemistry of Chlorine and Sulfur Compounds. Geophysical Monograph No. 3, pub. no. 642, Am. Geophysical Union, Waverly Press, Inc., Baltimore, Md., 1959, pp. 115-121.

Many of the conclusions presented in this paper are of an empirical or speculative nature, but they can evidently be tested by experiment. The reaction rates of sulfur dioxide with films and drops of water in the presence of impurities could for instance be measured by laboratory scale gas scrubbers. The time seems to be ripe, also, for a study of the physics and meteorology of radiation fogs, including water balance, heat balance, and the mechanism of mixing. Even more important is the systematic chemical analysis of the droplets of urban fogs, including their content of smoke particles. This should be preceded by the design of a fog water sampler which will not induce either the evaporation or the condensation of water during sampling. The whole life history of SO_2 from the instant when it enters the open air is of practical interest, because it is suspected to be the cause of a very great deal of damage. If we know how it reaches dangerous forms and concentrations, and how natural processes dispose of it, we shall be better able to reduce the harm it can do. - Author's Sum.

979. Motor Vehicles, Air Pollution, and Health. Part I. Summary - A Review of the Problem. II. Effects of Motor Vehicle Pollution on Health. III. Air Pollution from Motor Vehicles. A Report of Surgeon General to the U.S. Congress in compliance with Public Law 86-498, The Schenck Act, June 1962. USDHEW, U.S. Government Printing Office, Washington, D.C., 1962.

The report is the result of 2 yrs. intensive research conducted by the Div. Air Poll., U.S. Public Health Service, following legislation introduced by Congressman Paul F. Schenck (Ohio) and signed into law June 8, 1960 as PL 86-493. This law directed the Surgeon General of the PHS to conduct "a thorough study for the purpose of determining, with respect to the various substances discharged from the exhausts of motor vehicles, the amount and kinds of such substances which, from the standpoint of human health, it is safe for motor vehicles to discharge into the atmosphere under the various conditions under which such vehicles may operate." It further directed the Surgeon General to report back to the Congress his findings and recommendations not later than June 8, 1962. Although much of the information in the report is based on studies still in progress, it indicates clearly that pollutants from automobiles, trucks, and buses have harmful effects on man, vegetation, and many materials. - APCA

980. Owens, J.S.: Twenty-five years' progress in smoke abatement. Trans. Faraday Soc. 32:1234-1243, 1936.

Organized investigation into the degree of atmospheric pollution by smoke began in 1912. Since that time 158 stations making official reports have been in operation. These, however, have not all been in operation at the same time, nor have they all continued from the beginning until now. Therefore it became necessary to make some selection of stations in examining the variation of the deposit. This has been done by excluding from the comparison any station with less than eight consecutive years' observations, except in one or two exceptional instances.

Three elements of air pollution, total solids, sulfates, and tars, have been selected to give a reasonable measure of the progress made in the prevention of pollution of the air in a study of 23 selected cities.

981. Permissible immission concentrations of sulfur dioxide. VDI Specifications 2108. VDI-Handbuch Reinhaltung der Luft. VDI-Kommission Reinhaltung der Luft. November 1961. USDHEW, PHS, Div. of Air Pollution, Washington, D.C., 1963, 13 pp.

These VDI Specifications for Permissible Immission Concentrations, or PIC-values, of sulfur dioxide are outlined under the subject headings of: Occurrence of sulfur dioxide; Properties of sulfur dioxide; Effects of sulfur dioxide; and Exposure Limits. - APCA

982. Pollution and Environmental Health. Symposium Ser. 57, (35) Am. Inst. Chem. Eng. New York 1961. 73 pp.

Contents: Introduction. W.L. Faith. Governmental problems in environmental health. L.E. Burney. Industrial problems in environmental health. J.E. Hull. Educational problems in environmental health. J.E. McKee. Water supply. R.A. Morgen. Industrial wastes treatment. K.S. Watson. Air sanitation. L.B. Hitchcock. Food pollution. C.O. Chidester. Occupational health. S.C. Kyle. Radiation protection. W.B. Harris. Recent air pollution control developments: A review of published information. D.G. Stephan. The development of floating-bed scrubbers. A.W. Kielback. The use of structural ceramics in automobile exhaust converters. D.L. O'Brien, L.L. Johnson, and W.C. Johnson. Control of airborne emissions from sulfate pulping. N.J. Lardieri. Included in this vol. are papers presented at a symposium on the role of the chemical engineer in environmental health engineering held in Wash., D.C., and 3 papers on air pollution, also presented at the Washington Meeting. These papers indicate the contributions of chemical engineers to specific air pollution problems. - APCA

983. Proceedings of Air Pollution Research Planning Seminar, USDHEW, PHS, Div. Air Poll., Cincinnati, Ohio, Dec. 18-20, 1956.

Scientists from various scientific disciplines took part in this Seminar and discussed following aspects: Medical, Engineering, Agriculture, Meteorology, and Physical Sciences.

Toxicological studies of air pollutants were of major interest. Other major segments for discussion were pulmonary function and epidemiology. Need for more research was emphasized.

984. Quarterly Contaminant Report No. 13. October, November, December, Issued February 28, 1963. Prepared by Data Processing & Meteorology Section, Technical Services Division Air Pollution Control District, County of Los Angeles, Los Angeles, Calif.

This report, the thirteenth in a series of Quarterly Contaminant Reports, begins the fourth year in this series of Quarterly Reports. In this series of reports, monitored air contaminant data for the Los Angeles area have been presented in several forms.

This particular report presents the daily basin maxima for nine contaminants for the years 1960-1962; the diurnal variations of these various contaminants for the past three years for the stations now in operation; the station-by-station and all-time contaminant maxima for the fall quarter.

985. Raymond: General ideas on atmospheric pollution. Pharmacien France (Paris) No. 23:709-713 (Nov.) 1960.

In 1954 the question of increasing air pollution was referred to the Conseil Superieur d'Hygiene Publique de France, and in the same yr. the Minister of Public Health created an Interdepartmental Comm. of which the author was President. The

Comm. held meetings and attended them, read reports of other organizations, and made plans for international cooperation. For the area around Paris it was estimated that 50% of the pollution was attributable to domestic fires, 25% to exhaust fumes from automotive vehicles, and 25% to industrial sources. The substances ejected into the air are the usual gases (CO_2, CO, SO_2, and the nitrogen oxides), various solid and liquid particles, and the finer aerosol particles. Some of the studies contemplated are a geographic visualization of air pollution conditions in France, necessitating the establishment of sampling stations and of laboratory facilities for analysis; studies of variations of pollution according to time, necessitating a close liaison with meteorological services; and establishment of biological levels of the noxious actions of air pollution on humans and other living organisms, and the relation of pollution to morbidity and mortality. Some measures recommended for controlling pollution are to avoid excesses of SO_2 (by decreasing the sulfur content of fuel, as nearly as possible, to 0.7%); to avoid incomplete combustion of fuels by the increasing use of central heating, inspection of heating facilities, and schools for heating engineers, to eliminate smoke; to control emissions from automotive vehicles; and to apply strictly the law with regard to industrial establishments. - APCA

986. Restricting emission of hydrogen sulfide and other sulfur-containing compounds, except sulfur dioxide, from gas generators in coke, gas, and coal-constituent processing plants. VDI Specifications 2109. VDI-Handbuch Reinhaltung der Luft. VDI-Kommission Reinhaltung der Luft. May 1960. USDHEW, PHS, Div. of Air Pollution, Washington, D.C., 1963, 15 pp.

The information in these specifications is outlined under the major subject headings of: Technology; Measures for reduction of emission; and Guidelines for the restriction of emission. - APCA

987. Six Years of Research in Air Pollution. A Review of Grants-in-Aid, Contracts, and Direct Operations Sponsored by the Division of Air Pollution, Bureau of States Services, July 1, 1955 to June 30, 1961. USDHEW, PHS, Div. of Air Pollution, Washington, D.C., 1961.

This review of 6 yrs. of research in air pollution sponsored by the Div. of Air Pollution, U.S.P.H.S. has been assembled as a narrative summary under the following chapter headings: Engineering research in air pollution; Meteorologic research in air pollution; Chemical research in air pollution; Development of air monitoring; Research in air pollution instrumentation; Bio-medical research in air pollution; Development of technical assistance; Dissemination of research knowledge. There is also a bibliography of 623 references. The authors regret that except for an occasional instance where it was desired to achieve continuity or provide background, space limitations have prohibited the inclusion of studies made possible by non-federal sponsorship. In the recently published report of the Ad Hoc Task Group invited by the Surgeon General to identify goals for air pollution research over the next decade, expenditures for research in air pollution for the fiscal year 1960 were estimated at a total of $11,260,000, of which the federal government was spending $5,275,000, industry $4,065,000, and the states and communities $1,920,000. Note: The verso of the title page carries a notation to the effect that this publication is not generally available. Copies have, however, been distributed to the U.S.P.H.S. depository libraries which receive all U.S.P.H.S.-numbered publications and may be seen there. - APCA

988. State of California, Department of Public Health: California Standards for Ambient Air Quality and Motor Vehicle Exhaust. Technical Report. Berkeley, Calif. 1960, 136 pp.

I. The standards and their significance. II. Technical basis for standards for the quality of ambient air. III. The technical basis for motor vehicle exhaust standards. In establishing the standards, an attempt was made to determine what effects the various pollutants were known to have at various levels of concentration on human health and comfort, on animals and plants, and on visibility. The resulting air quality standards together with data concerning motor vehicle emissions and their reactions then became the basis for motor vehicle exhaust standards. The air standards do not establish a fine line below which is good air above which is bad air. They indicate the approx. point at which air under some circumstances may produce undesirable effects. - APCA

989. A Study of Pollution-Air. A Staff Report to the Committee on Public Works, U.S. Senate. Sept. 1963. 62 pp. U.S. Government Printing Office. Washington, D.C. 20401.

This Committee Print also appears as Appendix I, 401-462, of "Hearings before a Special Subcommittee on Air and Water Pollution of the Comm on Public Works, U.S. Senate, 88th Congress, 1st Session." In the preface to the staff report, Senator Edmund Muskie, as Chairman of the Special Subcommittee on Air and Water Pollution, states that providing air of good quality to all of our people is a challenge and an obligation for Government operations on all levels, and that the Comm. on Public Works of the U.S. Senate is prepared to accept this challenge and to do its part in meeting this obligation. The U.S.P.H.S. aided in reviewing the existing information and submitting a questionnaire to the States, the replies to the latter being used as a basis for the chapter dealing with State activity. Acknowledgement is made also of the technical assistance in completing the report which was given by several members of the Div. of Air Pollution of the U.S.P.H.S. The information is assembled under the following chapter headings: The problem; Effects of pollution; History of federal program; state, local and nongovernmental programs; Status of present technology; Standards for air pollution control; A look into the future. There are 2 appendixes: Summary of responses by States to questionnaire of April 30, 1963, on air pollution sent by Senator P. McNamara, Chairman, Senate Comm. on Public Works; and brief digests of state air pollution laws. - APCA

990. Stern, A.C. (editor): Air Pollution. Vol. I. New York Academic Press, 1962, 656 pp.

Tebbens. Reactions in the atmosphere. A.J. Haagen-Smit. Air ions. B.J. Steigerwald. Diffusion and stirring in the lower troposphere. R.C. Wanta. Atmospheric dispersion of stack effluents. G.H. Strom. Pt. II. - The effects of air pollution. Effects of air pollution on materials. J.E. Yocom. Effects of air pollution on visibility. E. Robinson. Effects of air pollution on plants. C.S. Brandt. Effects of air pollution on animals. H.E. Stokinger. Effects of air pollution on humans. J.R. Goldsmith. Pt. III. Measuring and monitoring air pollution. - Air sampling. E.R. Hendrickson. Source testing and monitoring. B.D. Bloomfield. Air analysis. M.B. Jacobs. Production of controlled test atmospheres. J.P. Lodge, Jr. Odor and its measurements. E.R. Kaiser. Meteorological measurements. E.W. Hewson. Automatic instrumentation. N.A. Renzetti. The air pollution survey. A.T. Rossano, Jr. Appendix: Characteristics of particles and particle dispersoids. Indexes. This book is concerned with the cause, effect, transport, measurement, and control of air pollution. It is intended for professionals, those trained in as wide a variety of callings as are represented among its authors: engineers, chemists, physicists, physicians, meteorologists, lawyers, agronomists, and toxicologists. This is a 2-vol.

work, and it may be helpful to the reader who does not find the subject of his interest in vol. 1 to outline the contents in vol. II. It covers 4 major areas: the emissions to the atmosphere from the principal air pollution sources; the control techniques and equipment used to minimize these emissions; the applicable laws, regulations, and standards; and the administrative and organizational procedures used to administer these laws, regulations, and standards. - APCA

991. Stern, A.C. (editor): Air Pollution. Vol. II. New York. Academic Press, 1962, 586 pp.

Contents: Pt. IV. - Air pollution sources. Combustion in furnaces, incinerators, and open fires. R.B. Engdahl. Automotive exhaust emissions. A.H. Rose, Jr. Mineral and metallurgical industry emissions. J.P. Sheedy and C.A. Lindstrom. Manufacture of the major inorganic acids and alkalis. A.N. Heller. Petroleum refinery emissions. H.F. Elkin. Sources of radioactive pollution. M. Eisenbud. Natural sources of air pollution. A.R. Jacobson. Pt. V. - Control methods and equipment. Process and source control. T. Hatch. Efficiency and selection of collectors. A.C. Stern. Source control by centrifugal force and gravity. K.J. Kaplan. Source control by filtration. C. Orr, Jr. and J.M. Dalla Valle. Source control by electrical, thermal, and sonic forces. C.F. Gottschlich. Source control by liquid scrubbing. W.E. Ranz. Nuisance abatement by combustion. R.J. Ruff. Source control by solid adsorption. A. Turk. Water pollution potential of air pollution control devices. F.E. Gartrell. Pt. VI. - Air pollution control. Air pollution control administration; planning and zoning. J.J. Schueneman. Air Pollution control legislation. S.M. Rogers and S. Edelman. Air Pollution Standards. A.C. Stern. Source inspection and survey. C. Gruber. Source approval and registration. P.W. Purdom. Public education, cooperation, and voluntary control activities. J.A. Maga. Air pollution personnel. Qualifications and training. E.T. Chanlett. Pt. VII. - Air pollution literature resources. J.S. Nader. Appendix I: List of potential air pollution producing industrial uses and operations. II. Petroleum refinery emission and loss factors. Indexes. - APCA

992. Szabo, L.: Air pollution over the city of Pecs. Nepegeszsegugy (Budapest) 43:46-48 (Feb.) 1962.

Pecs has a significant position in the industrial development of the country. The city is located in a valley with mountains of 500-600 m. to the north and hills of 100-300 m. to the south and east of the city. The roads at the periphery of the city are mostly macadam, the traffic is very heavy, and the level of pollution from dust is very high. In 1957 systematic measurements of atmospheric pollution were begun and are still being carried on. The majority of the measurements are made by sedimentation methods, with konimetry being used for particle counts. Atmospheric levels of gases are also being recorded. Average pollution has been found to be 850 tons/km.^{2}/yr. with a range of 148 to 3412 tons. Spectrometric analyses of sedimented dusts showed the following mineral content: Si, Fe, Al-above 10%; Ca, Cu, Mg, Na-1-10%; Ba, Co, Mn, Zn, U-0.10-1.0%. Pollution sources are a power plant, a coal-sorting establishment, a slate-processing area, and the Zsolnay factory. In the winter the average amount of dust collected was 71.44 g./m.^{2}/month; in the summer it was 262.7 g. This high value for the summer was explained by the fact that the slate quarries and the fly ash heaps were wet by rain or covered by snow during the winter. In the central part of the city, having streets with a solid road surface, the count was 10,000 particles/l.; in the periphery of the city, with macadam roads, 20-25,000 particles/l. The following levels, in mg./m.^{3}, are reported: SO$_2$, av. 2.09, max. 26.0; chlorides, av. 3.21, max. 8.85; NH$_3$, av. 5.66, max. 8.0. In heavy traffic areas, the CO$_2$ exceeded the suggested norm of 0.03% (by vol.) by 2 or 3 times. Even at points far from industrial areas, the CO$_2$ values were high. Meteorological factors considerably influenced the degree of pollution; the number of windless days averaged 22%. Measurements of the higher-altitude winds have shown them to be different from those at lower altitudes so that, contrary to expectations, the smoke settles back down over the city instead of diffusing out over the more rural area. Currently, the new power plant uses 280-300 railway cars of coal a day; about 50% of this comes out of the stacks as ash or fly ash; and about 128.7 tons of SO_2 are produced/day. In rainy or wet weather the atmospheric content of H_2SO_4 is high. During the growing season 80% of the leaves on vegetation in this area drop off, thus reducing the production of grapes and fruits by about 50%. This amounts to an estimated loss of 2.5 million forint (1 forint = 8½ cents). Respiratory illnesses in the city are estimated to be increased by 5-10% because of atmospheric pollution. - APCA

993. Thomas, M.D.: Air pollution review 1954-1955. Indust. Eng. & Chem. 48:1522-1527, 1956.

Interest in air pollution appears to be increasing. In this two-year period, many symposia have been held, the individual papers of which generally represent new research not previously discussed or published. The 1954 and 1955 ACS Air Pollution Symposia were devoted to analytical, biological and engineering aspects of air pollution and also to the chemical reactions of pollutants in the atmosphere. The First International Congress on Air Pollution in March 1955, sponsored by the American Society of Mechanical Engineers, considered many phases of the subject, such as the Beaver report and management, administrative engineering, meteorological, biological, and health problems. Eight papers were devoted to sulfur recovery in Great Britain and the United States, and five to air pollution in Europe. The Third National Air Pollution Symposium in April 1955 had 29 papers covering a wide range of subjects, including many different analytical methods for aerosols and gases and their application to the measurement of air pollution in Los Angeles and other cities, the effects of air pollution on plants, health considerations, and legal problems. 96 references.

994. Weisser, O.: Sulfide catalysts, their properties and uses. Internat. Chem. Eng. 3:388-424 (July) 1963.

The purpose of this article was to give a survey of the properties of sulfide catalysts and to call attention to the broad range of possibilities of using them. Even though the principal importance of their application is in large-scale production, further investigations, above all of their fundamental physicochemical properties, will permit their new use in areas other than the processing of fuel products. It is pleasant that the very latest work in this area continues to have in view the questions of basic research on sulfide catalysts, for only this course of action can lead to further and new uses of them in the chemical industry. 996 references. - Author's Abst.

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LIST OF JOURNALS AND THEIR ABBREVIATIONS

Air Eng.	Air Engineering
Am. Chem. Soc.	American Chemical Society
Am. Indust. Hyg. A. J.	American Industrial Hygiene Association Journal
*Am. Indust. Hyg. A. Quart.	American Industrial Hygiene Association Quarterly
A. I. Ch. E. J.	American Institute of Chemical Engineers Journal
Am. J. Botany	American Journal of Botany
Am. J. Clin. Path.	American Journal of Clinical Pathology
Am. J. Med.	American Journal of Medicine
Am. J. Nurs.	American Journal of Nursing
Am. J. Physiol.	American Journal of Physiology
Am. J. Pub. Health	American Journal of Public Health
Am. J. Vet. Res.	American Journal of Veterinary Research
**A.M.A. Arch. Indust. Health	American Medical Association Archives of Industrial Health
Am. Paint J.	American Paint Journal
A.P.I.	American Petroleum Institute
Am. Rev. Resp. Dis.	American Review of Respiratory Diseases
Am. Rev. Tuberculosis & Pulmonary Dis.	American Review of Tuberculosis and Pulmonary Diseases
Anal. Chem.	Analytical Chemistry
Anal. Chim. Acta	Analytical Chimica Acta
Ann. Allergy	Annals of Allergy
Appl. Microbiol.	Applied Microbiology
Appl. Spectroscopy	Applied Spectroscopy
Arch. Biochem. & Biophys.	Archives of Biochemistry and Biophysics
Arch. Environ. Health	Archives of Environmental Health
Biochem. Biophys. Acta	Biochemica and Biophysica Acta
Bull. Am. Meteorol. Soc.	Bulletin of the American Meteorological Society
Bull. Los Angeles County M. A.	Bulletin of the Los Angeles County Medical Association
Bull. Soc. Chim.	Bulletin de la Societe la Chimie
Bull. Soc. Chim. Belg.	Bulletin de la Societe la Chimie Belgique
Canadian J. Biochem. & Physiol.	Canadian Journal of Biochemistry and Physiology
Canad. J. Chem.	Canadian Journal of Chemistry
Chem. Eng.	Chemical Engineering
Chem. Eng. News	Chemical Engineering News
Chem. Eng. Progress	Chemical Engineering Progress
Chem. Processing	Chemical Processing
Chem. Rev.	Chemical Review
Chem. & Indust.	Chemistry and Industry
Clin. Chem.	Clinical Chemistry
Connecticut Med.	Connecticut Medicine
Control Eng.	Control Engineering
Dis. Chest	Diseases of the Chest
Eng. Res. Bull.	Engineering Research Bulletin

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*Am. Indust. Hyg. A. Quart. changed to: Am. Indust. Hyg. A. J. in Feb. 1958

**A.M.A. Arch. Indust. Health changed to: Arch. Environ. Health July 1960.

Fed. Proc.	Federation Proceedings
Gig. i Sanit.	Gigiena i Sanitaria
Heating, Piping, Air Condit.	Heating, Piping, and Air Conditioning
Indust. Eng. Bull.	Industrial Engineering Bulletin
Indust. & Eng. Chem.	Industrial and Engineering Chemistry
Indust. Med.	Industrial Medicine
Indust. Med. & Surg.	Industrial Medicine and Surgery
Indust. Wastes	Industrial Wastes
ISA J.	Instrument Society of America Journal
Internat. Arch. Allergy	International Archives Allergy & Appl. Immunol.
*Internat. J. Air Poll.	International Journal of Air Pollution
Internat. J. Air & Water Poll.	International Journal of Air and Water Pollution
Internat. J. Biometeorolog.	International Journal of Biometeorology
J. APCA	Journal of the Air Pollution Control Association
J. Allergy	Journal of Allergy
J. Am. Chem. Soc.	Journal of the American Chemical Society
J. A.M.A.	Journal of the American Medical Association
J. ASCE	Journal of the American Society of Chemical Engineers
J. Am. Vet. M. A.	Journal of the American Veterinary Medical Association
J. Am. Water Works A.	Journal of the American Water Works Association
J. Appl. Meteorol.	Journal of Applied Meteorology
J. Appl. Physiol.	Journal of Applied Physiology
J. Appl. Polymer Sc.	Journal of Applied Polymer Sciences
J. Atmospheric Sc.	Journal of Atmospheric Sciences
J. Chem. Physics	Journal of Chemical Physics
J. Chem. Education	Journal of Chemical Education
J. Chem. & Eng. Data	Journal of Chemical and Engineering Data
J. Chromatog.	Journal of Chromatography
J. Clin. Invest.	Journal of Clinical Investigation
J. Colloid Sc.	Journal of Colloid Science
J. Eng. Power	Journal of Engineering for Power
J. Fluid Mechanics	Journal Fluid Mechanics
J. Gas Chromatog.	Journal of Gas Chromatography
J. General Physiol.	Journal of General Physiology
J. Geophysical Res.	Journal of Geophysical Research
J. Infect. Dis.	Journal of Infectious Diseases
J. Inst. Fuel	Journal Institute of Fuel
J. Lab. & Clin. Med.	Journal of Laboratory and Clinical Medicine
J. Med. Chem.	Journal of Medicinal Chemistry
**J. Meteorol.	Journal of Meteorology
J. NCI	Journal of the National Cancer Institute
J. Occupat. Med.	Journal of Occupational Medicine
J. Org. Chem.	Journal of Organic Chemistry
J. Pharmacol. & Exper. Therapeutics	Journal of Pharmacology and Experimental Therapeutics
J. Phys. Chem.	Journal of Physical Chemistry
J. Physiol.	Journal of Physiology
J. Res. Nat. Bureau Standards	Journal Research of the National Bureau of Standards

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*Internat. J. Air Poll. changed to: Internat. J. Air & Water Poll. June 1961

**J. Meteorol. changed to: J. of the Atmospheric Sciences Jan. 1962.

J. Toxicol. & Appl. Pharmacol.	Journal of Toxicology and Applied Pharmacology
J. Water Poll. Control Fed.	Journal of Water Pollution Control Federation
Mech. Eng.	Mechanical Engineering
M. Ann. District of Columbia	Medical Annals of the District of Columbia
Mich. Acad. Sc., Arts, & Letters	Michigan Academy of Science, Arts, and Letters
Microchemical J.	Microchemical Journal
Military Med.	Military Medicine
Mitt. V. G. B.	Mitteilungen Verein der Grosskessel-Besitzer
Modern Castings	Modern Castings
Plant Dis. Rep.	Plant Disease Report
Plant Physiol.	Plant Physiology
Plant & Power Service Eng.	Plant and Power Service Engineering
Proc. Am. A. Cancer Res.	Proceedings of the American Association for Cancer Research
Pub. Health (British)	Public Health (British)
Pub. Health Rep.	Public Health Report
Pub. Works Mag.	Public Works Magazine
Quart. J. Roy. Meteorol. Soc.	Quarterly Journal of the Royal Meteorological Society
Record Chem. Progress	Record Chemical Progress
Refuse Removal J.	Refuse Removal Journal
Rev. Sc. Instruments	Review of Scientific Instruments
Revista de la Universidad Industrial de Santander	Revista de la Universidad Industrial de Santander
Rhodora	Rhodora
Sanitarian's J. Environ. Health	Sanitarian's Journal of Environmental Health
Trans. Am. Nuclear Soc.	Transaction of the American Nuclear Society

GLOSSARY OF ABBREVIATIONS

A.	Association
A. I. Ch. E. J.	American Institute of Chemical Engineers Journal
AISI	American Iron and Steel Institute
APCA	Air Pollution Control Association Abstracts. Published by the Air Pollution Control Association in Cooperation with the U.S. Public Health Service and the Library of Congress.
APCD	Air Pollution Control District
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
BAAP	Biological Aspects of Air Pollution, an Annotated Bibliography by Heimann, H., Brooks, H.M., Jr., and Schmidt, D.G. Federal Security Agency, PHS, Div. of Industrial Hygiene, Washington, D.C., April 1950.
CEGB	Central Electric Generating Board
CERL	Central Electric Research Laboratory
CSIR	Council on Scientific and Industrial Research
CWb	Contract Weather Bureau
Dept.	Department
Dept. Pub. Health	Department of Public Health
Div.	Division
IR	Information Report
ISA	Instrument Society of America
KB	Annotated Bibliography. The Effects of Atmospheric Pollution on the Health of Man, 1957. The Kettering Laboratory, University of Cincinnati, Cincinnati, Ohio
Nat. Acad. Sc.	National Academy of Sciences
NBS	National Bureau of Standards
NBSR	National Bureau of Standards Report
NCI	National Cancer Institute
Nat. Res. Council	National Research Council
PHEA	Public Health Engineering Abstracts, DHEW, PHS, Washington, D.C. (published monthly).
PHSB	Public Health Service Bulletin
PHSP	Public Health Service Publication
Proc.	Proceedings
RATSEC	Robert A. Taft Sanitary Engineering Center
RI	Report of Investigation
Res.	Research
SRI	Stanford Research Institute
TR	Technical Report

USBM	U.S. Bureau of Mines
USBMRI	U.S. Bureau of Mines Report of Information
USBMTP	U.S. Bureau of Mines Technical Paper
USDAB	U.S. Department of Agriculture Bulletin
USDATB	U.S. Department of Agriculture Technical Bulletin
USDC	U.S. Department of Commerce
USDHEW	U.S. Department of Health, Education, and Welfare
USDI	U.S. Department of the Interior
USNBS	U.S. National Bureau of Standards
USPHS	U.S. Public Health Service
WHO	World Health Organization
WSL	Warren Spring Laboratory

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